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EDITORIAL NOTES.

THE Editors of the Geological Magazine desire to take this opportunity of thanking their friends and subscribers for the kindly expressions of good-will and promises of practical support that have followed the issue of the circular sent out with the December Number. They also wish to say that it is their hope and intention to make the Magazine of service to the geological world as a vehicle for the publication of original work, also as a review of the progress of the science and a means of intercommunication between fellow-workers in different parts of the world. In furtherance of this latter object, they appeal especially to geologists in the British Dominions beyond the seas and in foreign countries to continue to send copies of their publications for review. As a matter of fact, a large number of such publications are actually received, but it is feared that in the last three or four years a good many more never reached their destination. It is certain that a free interchange of ideas between widely separated parts of the world is one of the surest ways of forwarding the progress of knowledge. Geologists in the less developed countries where "fresh fields and pastures new" are constantly turning up, enjoy many opportunities denied to those in regions where field-work and mining investigations have been carried on for over a century and where the great fundamental principles of our science have long been applied and geological features mostly worked out. In new countries geologists and explorers also develop their own theories and represent fresh phases of thought, which should be disseminated as widely as possible for the benefit of mankind at large. The Editors trust that their readers will assist them in their ambition to help in the spreading of new light in the geological world.

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The Annual General Meeting of the Geological Society of London took place on Friday, February 21, when the medals and awards were handed to the recipients, whose names have already been announced in this Magazine. A portrait of Dr. Henry Woodward, F.R.S., painted by Miss Lancaster Lucas, was formally accepted as a gift to the Society. The President also delivered his annual address, the subject chosen being "The Structure of the Weald and Analogous Tracts". It was pointed out how deep borings have shown that the Wealden anticline is a superficial phenomenon imposed on a huge wedge of Jurassic and Lower Cretaceous rocks forming a deep syncline: the accumulation of the Mesozoic sediments took place in a gradually deepening trough with

relatively stable sides, and the anticlinal structure was due to a slight reversal of the earlier direction of movement. Similar conceptions were extended to the Jurassic rocks of the Midlands and of Yorkshire; in both cases the recumbent wedge was found to be in evidence, and such structures can probably be traced in Triassic, Carboniferous, and even older rocks. It was also pointed out that where such formations lie above sea-level their outcrops represent areas of maximum development and coincide with the deepest parts of the old troughs. These considerations may be of wide application and have a practical bearing.

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The Report of the Council of the Geological Society of London, presented at the Annual General Meeting on February 21, must be regarded as highly satisfactory considering all the circumstances of the time, since it shows that the Society has been able to keep most of its activities unimpaired. The number of Fellows shows, as might be expected, a slight decrease, and there are a good many vacancies in the list of Foreign Members and Correspondents. The financial position is satisfactory, in spite of the increased cost of nearly everything, and more especially of paper and printing. The production of volume lxxiii of the Quarterly Journal cost over £860 exclusive of postage. The generous action of the Council in remitting the annual contributions of those Fellows on active service has led to a diminution of receipts for some years, but that is now presumably a thing of the past. An increase of income may be expected in the future from the admission of women as Fellows, although this is not likely to be very great, at any rate for some time to come. It is well known that the Society's library has been found of the utmost value during the War to the Admiralty, the War Office, and many other Government departments, since it contains publications, and especially maps, not to be found elsewhere in this country. It is gratifying to observe that a small sum has been set aside from the Prestwich Trust Fund for the purchase of books on economic geology, in which the library is still somewhat deficient. It is certain that the demand for economic literature will increase greatly in the immediate future, and this is a step in the right direction.

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The *Cambridge University Reporter* for February 18 last announces the subject for the Sedgwick Prize Essay for 1922 as follows: "The Petrology of the Arenaceous Sediments of Lower Cretaceous Age in England, with special reference to the Source of the Material." The prize, which is triennial and of the value of about £80, was not awarded in 1915 or 1918, as is natural under the circumstances, but even in normal times it has happened that no essays have been sent in. This is possibly owing to one of the conditions: that the prize shall be open to all graduates of the University who have resided in Cambridge for sixty days during the twelve months preceding the date at which the essay must be sent in. This greatly limits the number of possible candidates, since

few geologists can afford the time to reside for a term in Cambridge for this special purpose.

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The list of fifteen candidates selected by the Council for election to the Royal Society contains several names of interest to geologists. The many contributions of Dr. J. W. Evans to geology and mineralogy are well known to all, as well as his wide experience of travel and his activities at the Imperial Institute. He is also now taking a prominent part in the organization of the new Imperial Mineral Resources Bureau. Dr. W. D. Matthew is a Canadian palæontologist who has contributed largely to our knowledge of the fossil mammals of the North American Continent, especially by his generalizations as to the phylogeny of the Cervidæ, Felidæ, and other groups. Sir Charles F. Close, Director-General of the Ordnance Survey, is responsible for the excellent maps which are so invaluable for geological work of all kinds in this country. Mr. E. Heron-Allen, although primarily a protozoologist, recently gave a most interesting lecture before the Geological Society on the application of X-ray photography to the elucidation of the structure of minute fossils, especially Foraminifera, showing results of remarkable technical excellence.

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The retirement of Sir Lazarus Fletcher, Knt., M.A., F.R.S., Director of the Natural History Museum, marks the disappearance from active service of the last of the four Keepers who under Professor Owen represented this great section of the old British Museum in Bloomsbury, and were responsible for the transfer of its several collections in 1880 from Great Russell Street, W.C., to their present home in Cromwell Road, South Kensington. Mr. Fletcher, who, after a remarkably brilliant career as a student and mathematician at the University of Oxford, entered the Museum as a First-class Assistant in Mineralogy in March, 1878, succeeded Professor Story Maskelyne as Keeper of Minerals in 1880, a post which he held for twenty-nine years, being made Director of the Museum in 1909, and retiring after ten years in the month of March. During this long period of forty-one years Sir Lazarus Fletcher has rendered important services to science and to the Museum; amongst others may be specially mentioned the arrangement of the entire Mineralogical Collection, and the preparation and publication of a most admirable series of Guide-books, namely, an Introduction to the Study of Meteorites, 1881; to Minerals, 1884; to Rocks, 1895; and, still earlier, an Optical Indicatrix in 1872. Numerous are the honours, medals, and awards which have been conferred upon Sir Lazarus Fletcher, but notwithstanding he is probably one of the most modest, reserved, and retiring scientific men of eminence in London.

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The *Times* of March 13 last announced the appointment of Dr. Sidney Frederick Harmer, F.R.S., as Director of the Natural History Museum in place of Sir L. Fletcher. Dr. Harmer, who is the son of

Mr. F. W. Harmer, M.A., F.G.S., was formerly Fellow of King's College, Lecturer in Zoology, and Superintendent of the University Museum of Zoology at Cambridge. In 1907 he was appointed Keeper of Zoology at the Natural History Museum, and it is understood that he will continue to hold this post for a time, conjointly with the Directorship. Dr. Harmer has specialized in Invertebrata, especially Polyzoa, and with Dr. Shipley, now Vice-Chancellor of the University, he edited the Cambridge Natural History. Geologists may feel every confidence that in Dr. Harmer's hands the interests of their science will receive due consideration, and that every facility will be afforded to enable the specialists in charge of the different branches of the Museum to maintain the high standard of the collections and to continue their invaluable work of investigation and research. This appointment is very satisfactory also in that it shows the success of the protest put forward by many leading zoologists and geologists against the proposed appointment of a layman to this important post, which may be regarded as the blue ribbon of the biological world.

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The *Mining Magazine* for February last contains a reprint of an interesting lecture by Mr. J. Morrow Campbell on the minerals of the Tavoy district of Burma, a region which has lately come into so much prominence as a producer of tungsten ores. As is well known, the origin and mode of occurrence of the ores in Tavoy have led to a good deal of controversy. Without entering in any way into the merits of the rival theories, it is perhaps permissible to point out the great interest which attaches to such investigations from the scientific as well as from the practical point of view. The origin of ore-deposits and the laws governing their formation are matters within the province of the theoretical petrologist just as much as the study of the silicates, and they possess the added advantage of possibly leading to results of practical value in the prospecting and locating of valuable mining areas. If it can be established, as seems possible, that ores of particular metals commonly show definite relations to one another and to certain types of igneous rock, it will become possible to draw conclusions as to the probability of successful development of metalliferous areas by exploration of a particular kind, such as diamond drilling, for example. As a concrete instance the well-known relations of copper and tin ores in Cornwall may be mentioned, or the association of platinum with serpentine, which actually led to the discovery, based on scientific reasoning, of platinum in the Serrania de Ronda in the South of Spain. In this way the theoretical and the practical geologist can work hand in hand for their mutual benefit and the good of the science in general.

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After two years' interval owing to war conditions, the British Association for the Advancement of Science will resume its series of annual meetings this year at Bournemouth, from September 9 to 13, under the presidency of the Hon. Sir Charles Parsons, K.C.B., F.R.S.

ORIGINAL ARTICLES.

I.—Cambrian Hyolithidæ, etc., from Hartshill in the Nuneaton District, Warwickshire.

By E. S. Cobbold, F.G.S.

(PLATE IV.)

PROFESSOR CHARLES LAPWORTH, in his "Sketch of the Geology of the Birmingham District",[1] gives a list of species (pp. 343 and 349) from "the Hyolite Limestone" and the associated shales as provisionally determined by Miss E. M. R. Wood (Mrs. Shakespeare). He referred the beds generally to the Lower Cambrian and paralleled them approximately with the fossiliferous beds of Comley, the details of which had not then been worked out. The present study of the Hyolithidæ, etc., of Woodlands Quarry, fully confirms the reference to the Lower Cambrian, and it would seem that the position of the Hyolite Limestone in the faunal sequence is near to or a little below that of the *Olenellus* and Grey Limestones of Comley at the local summit of the Lower Cambrian. The evidence of this is indirect, for no species has yet been identified from both localities, unless it be *Micromitra labradorica*, Billings sp. Nevertheless, the Hyolithidæ, etc., found in North America that are nearest to, or representative of, those of Hartshill, are there associated more or less intimately with a number of trilobites and brachiopods that find their representatives in the Comley Limestones.

To put the matter in another way: the Hyolithidæ, etc., of Hartshill, combined with the trilobites of Comley, make up what is practically the same Lower Cambrian fauna that is found at North Attleboro', Massachusetts, in the exposures of Manuel's Brook, Newfoundland, and at many intermediate positions.

During the past four years Mr. L. J. Wills, F.G.S., has kindly sent me, for comparison with the forms found at Comley, a number of specimens that he had collected from Woodlands Quarry. This communication is the result of a critical examination of these specimens, without any previous reference to Mrs. Shakespeare's determinations above alluded to.

The specimens are preserved in the Birmingham University collection, and are found upon a number of pieces of red sandy limestone, specially characterized by plentiful tubes of *Coleoloides* and *Hyolithus*. A few other fossils occur and also some very obscure fragments of trilobites which are quite indeterminable. Where unweathered the rock is of a dull purplish-red colour, on which the white sections and fragments of shells stand out clearly. Usually the examples are very unsatisfactory for the shells break open tangentially and rarely show their surface characters. Where weathered the rock becomes brick-red and the fossils occur as casts or partially weathered exteriors, which may be more or less completely freed from the matrix.

Invagination of shells is very frequent, as many as three or four shells of the same species are sometimes found one within another,

[1] Proc. Geol. Assoc., vol. xv, pt. ix, 1898.

and, where they have the same orientation in cross section and are closely approximated, they give the appearance (noted by Billings[1] for *H. communis*) of the individual shell being "thickened by concentric laminæ, and thus approaches the structure of *Salterella*".

A few detached opercula occur, usually very indifferently preserved, and it is impossible to say, without reserve, to which species they belong.

Descriptions of Species.

HYOLITHUS, Eichwald.

Sub-genus Orthotheca, Novak.

Hyolithus (Orthotheca) de Geeri, Holm. (Pl. IV, Figs. 1–6 and (?) 7–9.)

Hyolithus (O.) de Geeri, Holm, Sver. Geolog. Undersökning, ser. C, No. 113, p. 54, pl. i, figs. 25–7, 1893.
Orthotheca de Geeri, Holm, Lapworth, Proc. Geol. Assoc., vol. xv, p. 345, 1898.

Shells referred to this species are very plentiful in the collection. They agree closely with Holm's figures and description, the only difference observed being that the apical angle varies from 12° to 8° (taper 1 in 5 to 1 in 7) instead of from "9° to 8°".

The ratio of the sectional diameters also varies somewhat, but is always near to 3 to 2.[2] The surface has a texture as of ground glass, with very faint striæ of growth, which are transverse on both dorsal and ventral sides. The aperture is frequently seen, but in no instance has the apex been preserved. In two cases the internal cast has a smooth convex end representing a septal division below which the shell has been apparently decollated.

Operculum.—A few examples of opercula occur that are referred with reserve to this species. In outline they agree with the transverse section of the principal shell; the margin is practically in one plane; the nucleus is situated at about two-thirds of the diameter from the dorsal edge; the semi-conical portion is clearly marked off by two radiating lines, and in addition to these, on the exterior surface, two other radiating lines are seen, marking off triangular portions on each side similar to those of the operculum of *Hyolithus, sens. strict.*, at the places where the curvature changes from the conical (dorsal) portion to the upturned (ventral) part; at the bases of these triangles the margin is seen in a side view to be a little depressed from the general plane; the ventral margin is marked by a slightly raised, rounded fillet, between which and the nucleus there is a pit-like hollow.

H. (O.) Johnstrupi, Holm,[3] has a cross section that is somewhat similar, but the dorso-ventral diameter is proportionately greater and the surface marks are described as being rather strong.

H. primævus, Groom,[4] from Malvern, has a very similar cross section but a rather greater apical angle (10° to 11°) and indications

[1] Billings, *Canada Naturalist and Geologist*, ser. II, vol. vi, p. 214.
[2] Where the ratios of the diameters are mentioned in this paper it is intended to indicate those of the width to the dorso-ventral diameter.
[3] Op. cit., p. 56, pl. i, figs. 28–33.
[4] Q.J.G.S., vol. lviii, p. 116, 1902.

of longitudinal striæ; it is uncertain whether this species is an *Orthotheca* or *Hyolithus*.

H. (*O.*) *Emmonsi*, Ford,[1] appears to be the nearest American species; the cross section and rate of taper are very similar, the principal distinguishing feature being a shallow hollow all along the dorsal side, making it slightly concave.

Horizon and Locality.—Lower Cambrian: red sandy limestone of Woodlands Quarry, Hartshill.

(? Sub-genus) Hyolithus[2] (Holm).

Hyolithus (*H.*) *alatus*, sp. nov. (Pl. IV, Figs. 13–15 and (?) 16.)

? *Hyolithus* cf. *obscurus*, Holm, Lapworth, Proc. Geol. Assoc., vol. xv, pt. ix, p. 343, 1898.

Type-specimen [34].[3]

Diagnosis.—Shell slightly curved toward the ventral side, taper about 1 in 4 (equivalent apical angle 14°); greatest length about 24 mm., diameter of aperture 6 mm.; apex having the same rate of taper as the remainder of the shell, often filled with calcite, but no septa have been observed. Section, dorsal face gently convex centrally, almost concave towards the lateral angles which form rounded projections, ventral face strongly convex centrally, slightly concave towards the lateral angles, ratio of axis 1 : ·6. Surface, resembling ground glass, but marked with striæ of growth, which are transverse on the ventral side, but convex forwards on the dorsal. Aperture in two planes, dorsal lip projecting to a distance equal to about two-thirds of the longer diameter; ventral lip a little sinuous, with a rounded notch on the centre line.

Operculum (?): several examples occur which are assigned with little hesitation to this species. In the view of the operculum as usually seen the outline is nearly circular (Fig. 16), but when the plate is tilted so as to bring the dorsal margin parallel to the line of sight the outline conforms very closely to the section of the shell. In the circular view the nucleus is distant about four-fifths of the diameter from the dorsal margin, and the sides of the conical part meet at an angle of 110° to 120°; the ventral portion is strongly concave and rises in front (the upper side in the figure) like an upturned brim to a soft felt hat to about twice the height of the nucleus. The curve joining the ventral to the dorsal margin is slightly indented in correspondence with the alate lateral angles of the shell.

Comparisons with other species.—The section of *H. alatus* is of the same character as that of *Hyolithus* sp. *a*, Groom,[4] but is not provided with a "blunt keel", and the proportion between the diameters is different. The species is readily recognized by its alate cross section.

H. obscurus[5] has two impressed lines on the dorsal side close to

[1] *Amer. Journ. Sci.*, ser. III, vol. v, p. 214, figs. 3*a–e*.

[2] It seems doubtful whether Eichwald's genus *Hyolithus* can be used, *sens. str.*, also as a *sub-genus*.—H. W.

[3] Numbers in square brackets are those attached to the blocks on which the specimens are found.

[4] Groom, op. cit., 1902, p. 116.

[5] Holm, op. cit., 1893, p. 76, pl. v, figs. 29–33.

each lateral angle; these cause the angles to project something like those of *H. alatus*; the ventral side is, however, bluntly keeled.

Horizon and Locality.—Lower Cambrian: red sandy limestone of Woodlands Quarry, Hartshill.

Hyolithus (*H.*) *biconvexus*, sp. nov. (Pl. IV, Figs. 10–12.)

? *Hyolithus* cf. *lenticularis*, Linnarsson, Lapworth, Proc. Geol. Assoc., vol. xv, pt. ix, pp. 343, 349, 1898.

Diagnosis.—Shell straight, taper 1 in 3 to 1 in 4 (equivalent apical angle 18° to 14°), length of type-specimen 14 millimetres, diameter of mouth in another specimen 5 mm. Section biconvex, dorsal face moderately convex, ventral strongly convex, ratio of diameters 1 to ·66, lateral angles rather sharply rounded; aperture in two planes, dorsal lip projecting but little; surface marked by fairly strong ridges of growth, spaced about eight to the millimetre in the body of the shell, but closer near the aperture, and having a tendency to be alternately strong and weak; the ridges are strongly bent forwards on passing the lateral angles; interior, surface apparently smooth.

Operculum (?): one or two examples of opercula that may belong to this species have been found. They are constructed on the same general lines as those assigned to *H. alatus*, but are more oval in outline as usually seen in the rock, the ventral margin does not rise to so great a height above the convex conical portion of the plate, and the sides of the conical portion meet at an angle of about 90°.

Comparison with other species.—*H. biconvexus* has a similar section to that of *H. acadica* (Hart MS.), Walcott,[1] which, however, has faint longitudinal striæ and a greater apical angle.

The Middle Cambrian form *H. socialis*, Linnarsson,[2] has a somewhat similar section, but a smaller apical angle, and is provided with a rounded keel on the ventral side.

H. lenticularis, as figured by Holm,[3] has its dorsal and ventral sides equally convex.

Horizon and Locality.—Lower Cambrian: red sandy limestone of Woodlands Quarry, Hartshill.

Hyolithus (*H.*) *Willsi*, sp. nov. (Pl. IV, Figs. 17, 18.)

? *Hyolithus* cf. *princeps*, Billings, Lapworth, op. supra cit., pp. 343, 349.

The type-specimen [27 and 28] exhibits a fragment of the dorsal face together with (on the other side of the piece of limestone) the much-weathered ventral face, from which the outline of the shell may be reconstructed; two oblique sections are also visible.

Diagnosis.—Shell large, straight, tapering at the rate of 1 in 2·6 (equivalent apical angle 22°). Section uncertain (the specimen

[1] U.S. Geol. Surv., Bull. 10, 1884, p. 20, pl. ii, fig. 5.
[2] Holm, op. cit., 1893, p. 78, pl. i, figs. 72–7.
[3] Id., p. 77, pl. v, figs. 23–8.

has uneven surfaces, indicating some amount of damage or compression when freshly embedded in the matrix), ratio of axes (as preserved) 1 to ·5; aperture in two planes, dorsal lip projecting a distance equal to one-third of the width (in the type-specimen it is somewhat emarginate at the central line); surface marked near dorsal lip with obvious lines of growth, elsewhere unknown; internal surface finely granular; dimensions, the complete shell (as reconstructed) would be about 63 millimetres long and the width of aperture (as preserved) is about 20 mm.

Comparison with other species.—*H. Willsi* is only exceeded in size by the Bohemian species *H. giganteus*, Novak[1] (Ordovician), and *H. maximus*, Barrande (Middle Cambrian).[2] It is of about the same length as *H. princeps*, Billings,[3] which, however, is much more acuminate.

H. Willsi agrees closely in some respects with *H. excellens*, Billings,[4] from the Red Limestone of Trinity Bay, Smith's Sound, Newfoundland. The Hartshill species has the same length, width, rate of taper, and projection of dorsal lip, but its other characters (convexity and surface marks) are unknown, and until further material is available from Hartshill it seems best to describe it under a new specific name.

Horizon and Locality.—Lower Cambrian: the red sandy limestone of Woodlands Quarry, Hartshill.

Hyolithus (*H.*) *æquilateralis*, sp. nov. (Pl. IV, Figs. 21, 22.)

Type-specimens [25, 2].

Diagnosis.—Shell straight and tapering uniformly, so far as known, at a rate of about 1 in 5 (equivalent apical angle about 12°), apex not preserved. Section, dorsal face very gently convex, lateral angles rounded, ventral face consisting of two surfaces which are very slightly, if at all, more convex than the dorsal and are joined by a rounded angle, the whole forming an equilateral triangle; aperture in two planes, dorsal lip projecting to a distance of about one-quarter of the diameter, exterior not known.

Remarks.—This species seems somewhat scarce; where the cross section can be observed it is easily recognized, but otherwise it is difficult to distinguish it from some views of *H.* (*O.*) *de Geeri*, with which it agrees in the rate of taper. It is near to *H. Americanus*, Billings,[5] which has a similar triangular section, but is not so equilateral; the projection of the dorsal lip also appears to correspond. The exterior of that species is marked by transverse lines of growth and longitudinal striæ.

Horizon and Locality.—Lower Cambrian: the red sandy limestone of Woodlands Quarry, Hartshill.

[1] K. Böhm. Gesell. der Wissensch., Folge vii, Band iv, No. 4, p. 19, pl. iv, figs. 40–50, 1891.
[2] *Sil. Syst. de Bohême*, vol. iii, p. 5, pl. x, figs. 22–9, 1867.
[3] *Can. Naturalist and Geologist*, N.S., vol. vi, p. 216, 1872.
[4] Id., p. 471.
[5] Billings, op. cit., 1872, p. 215.

SALTERELLA, Billings.

Salterella (?) *curvata*, S. & F. (Pl. IV, Figs. 16*a*, *b*.)

Salterella curvatus, S. & F., Bull. Mus. Comp. Zool. Harvard, vol. xvi, p. 34, pl. ii, fig. 22, 1888.
,, ,, ,, Walcott, Tenth Ann. Rep. U.S. Geol. Surv., p. 625, pl. lxxix, figs. 3, 3*a*, 1890.
,, ,, ,, Grabau, Occ. Papers Boston Nat. Hist. Soc., vol. iv, p. 660, pl. iii, 1900.

Two specimens on one block [38] in the collection suggest a reference to Shaler and Foerste's species; they lack, however, the cone-within-cone structure of shell that characterizes the type species for the genus *Salterella rugosa*. They are curved tapering tubes with a rounded or somewhat oval section, scarcely three millimetres long and less than one mm. in diameter. The aperture is not seen, the open ends being fractured. The shell is thick; its outer surface is smooth but marked near the apex with very faint transverse striæ spaced about eight to the millimetre. The interior is also smooth, and though filled with calcite shows no trace of annulations or septal divisions. The rate of taper is about 1 in 4, equivalent to an apical angle of 14°.

Horizon and Locality.—Lower Cambrian: the red sandy limestone of Woodlands Quarry, Hartshill.

COLEOLOIDES, Walcott.

Coleoloides typicalis, var. *multistriata*, var. nov. (Pl. IV, Figs. 30, 32.)

Coleoloides typicalis, Walcott, U.S. Nat. Mus. Proc., vol. xii, pl. xxxvii, 1889.
,, ,, ,, U.S. Geol. Surv., Tenth Ann. Rep., p. 624, pl. lxxix, figs. 6, 6*a*, 1890.
,, ,, ,, Lapworth, Proc. Geol. Assoc., vol. xv, pt. ix, p. 343, 1898.

Straight tubes of circular section with very slight taper are plentiful in the rock specimens to hand, but very rarely preserve the original surface.

In two instances [15 and 38], however, the external surface marks are perceptible: they are very closely set spiral lines, numbering about seventy in the whole circumference of the tube, which is one millimetre in diameter; they are inclined at such an angle as to make one complete circuit of the tube in a length equal to about 10 diameters.

C. typicalis, Walcott, as figured, has much fewer spiral lines and they are set at a more acute angle.

The tubes vary in diameter from 1 to 1·3 millimetres.

Horizon and Locality.—Lower Cambrian: red sandy limestone of Woodlands Quarry, Hartshill.

BRACHIOPODA.

MICROMITRA (Meek), Walcott.

Micromitra cf. *Phillipsi*, Hall, sp. (Pl. IV, Fig. 25.)

Obolella Phillipsi, Holl, Q.J.G.S., vol. xxi, p. 102, figs. 10*a–c*, 1865.
O. (?) *Phillipsi* (Holl), Davidson, Pal. Soc. Mon. British Fossil Brachiopoda, vol. iii, pt. vii, p. 62, pl. iv, figs. 17–19, 1866.

Kutorgina cingulata, Davidson, id., p. 342, pl. i, fig. 25, 1871.
K. cingulata Phillipsi (Holl), Matley, Q.J.G.S., vol. lviii, p. 145, 1902.
Micromitra (*Paterina*) *Phillipsi* (Holl), Walcott, U.S. Geol. Surv. Mon., vol. ii, p. 351, pl. iii, fig. 8, 1912.

One external cast of a ventral valve and a few obscure fragments are very like specimens obtained at Malvern and Comley.

The general outline and surface characters agree with Holl's species, but, in the absence of further specimens and particularly those showing the false area and pseudodeltidium, the reference is made with considerable reserve.

Horizon and Locality.—Lower Cambrian: the red sandy limestone of Woodlands Quarry, Hartshill.

GASTEROPODA.

Platyceras, Conrad.

Platyceras cf. *primævum*, Billings. (Pl. IV, Fig. 34.)

Platyceras primævum, Billings, Can. Nat., N.S., vol. vi, p. 220, 1871.
,, ,, ,, Walcott, U.S. Geol. Surv., Bull. 30, p. 130, pl. xii, figs. 5, 5*a*, 1886.
,, ,, ,, Grabau, Occ. Papers Boston Nat. Hist. Soc., vol. iv, pt. iii, p. 628, pl. xxxi, figs. 7*a*, *b*, 1900.

A single specimen [37] consisting of an internal cast of a whorled shell with oval aperture appears to be nearly allied to or, possibly, identical with Billings' species. In the absence of better preserved specimens the reference must remain doubtful.

Horizon and Locality.—Lower Cambrian: the red sandy limestone of Woodlands Quarry, Hartshill.

Helcionella, Grabau & Shimer.

Helcionella (?) *emarginata*, sp. nov. (Pl. IV, Figs. 26, 27.)

The type-specimen [46] shows two internal casts, from one of which a fragment of the external cast was preserved during development, indicating the character of the surface.

Diagnosis.—Shell strongly recurved so that the apex projects beyond the limit of the posterior margin; aperture almost circular, slightly flattened anteriorly owing to the presence of a rhomboidal notch; apex (in the cast) somewhat blunt; exterior with many irregular raised lines of growth, some of which are more pronounced than others; all conform in shape to the apertural notch; no radiating striæ detected in the material to hand; interior marked with several, irregularly arranged raised concentric lines, seen as depressions in the cast, in addition to which there are in one of the specimens (Fig. 26) two symmetrically arranged rounded and ill-defined depressions, that simulate muscle-scars of Brachiopoda, but it seems more probable that they are somewhat fortuitous and possibly connected with the trace of the apertural notch.

Dimensions.—Length of aperture about 4·5, width 5, height 2·5 mm.

Observations.—So far as known to the writer the aperture of *Helcionella* is entire. The notch in this species is suggestive of

Bellerophon, and it is possible that it should be relegated to a new genus and placed among the Heteropoda. The general form is suggestive of the ventral valve of an elevated Brachiopod, but the notch being at the anterior margin cannot be a pedicle opening.

Pelagiella, Matthew,[1] and *Watsonella*, Grabau,[2] have similar notched margins, but are very different in other respects.

Horizon and Locality.—Lower Cambrian: the red sandy limestone of Woodlands Quarry, Hartshill.

STENOTHECA (Salter), Grabau & Shimer.

Stenotheca abrupta, Shaler & Foerste (?). (Pl. IV, Figs. 28, 29.)

Stenotheca rugosa, var. *abrupta*, S. & F., Bull. Mus. Comp. Zool., vol. xvi, p. 29, pl. i, figs. 9*a*, *b*, 1888.

S. (?) *rugosa*, var. *abrupta* (S. & F.), Walcott, Tenth Ann. Rep. U.S. Geol. Surv., p. 617, pl. lxxiv, figs. 6, 6*a*, 1890.

S. abrupta (S. & F.), Grabau, Occ. Papers Boston Nat. Hist. Soc., vol. iv, pt. iii, p. 637, pl. xxxi, figs. 12*a–c*, 1900.

A few internal casts agreeing closely with Walcott's figures seem to indicate the presence of this form.

They show from six to ten rounded corrugations; the section is an elongate oval with the axes in the proportion of 1 to ·5; the apex is curved over so as to stand approximately above the posterior margin of the aperture. Exterior not observed; no thickening of the ventral margin, such as is spoken of by Grabau (op. supra cit.) has been detected. Dimensions (of largest specimen): length 5, width 2·5, height 4·5 mm.

In the absence of good exteriors of these shells it seems doubtful whether they should not be referred to *Helcionella*, the genus proposed in 1910 by Grabau & Shimer for forms congeneric with *Metoptoma rugosa*, Hall. It is consequently necessary to give the specific reference with reserve.

Locality and Horizon.—Lower Cambrian: the red sandy limestone of Woodlands Quarry, Hartshill.

LAMELLIBRANCHIATA.

FORDILLA, Barrande.

Fordilla troyensis, Barrande (?). (Pl. IV, Fig. 33.)

Fordilla troyensis (Barrande), Walcott, Bull. U.S. Geol. Surv., No. 30, p. 125, 1886.

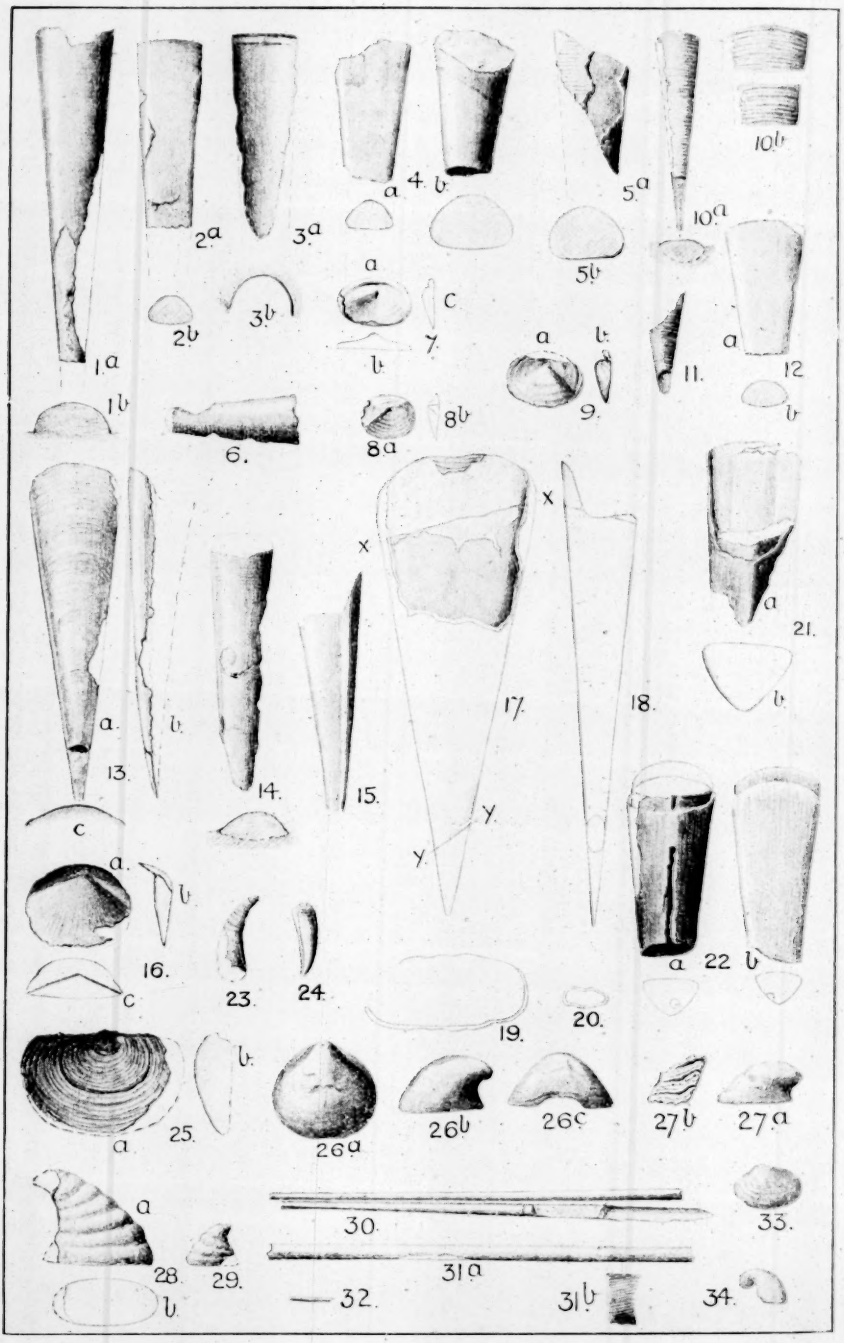
,, ,, ,, Walcott, Tenth Ann. Rep. U.S. Geol. Surv., p. 615, pl. lxxiii, figs. 2, 2*a–c*, 1890.

,, ,, ,, Grabau, Occ. Papers Boston Nat. Hist. Soc., vol. iv, pt. iii, pp. 610, 611, 633, 1900.

A single shell occurs with the Hyolithidæ from Woodlands Quarry agreeing in many respects with Walcott's figures for this species.

It appears to be the somewhat worn exterior of a left valve, and is about 3 mm. long with the umbo situated a little in advance of the mid-length. No radial striæ are preserved, and the concentric lines of growth are not so thickly set as those shown in Walcott's figures.

[1] Trans. N.Y. Acad. Sci., vol. xiv, p. 131, 1895.
[2] Op. cit., p. 631, 1900.



E. S. Cobbold, del. Bale & Sons, imp.

LOWER CAMBRIAN HYOLITHIDÆ, &c., FROM HARTSHILL.

Horizon and Locality.—Lower Cambrian: the red sandy limestone of Woodlands Quarry, Hartshill.

I desire to express my gratitude to Mr. L. J. Wills for allowing me to study and describe his specimens, and also to Dr. F. A. Bather for much kind help in reference to the literature of the genera *Salterella*, *Stenotheca*, and *Helcionella*.

EXPLANATION OF PLATE IV.

NOTE.—The numbers in square brackets are those attached to the blocks on which the specimens are found. All belong to the collection of the Birmingham University.

Hyolithus (*Orthotheca*) *de Geeri*, Holm. × 2. (See p. 150.)

FIG.

1 [37]. Ventral side; *a*, exterior; *b*, section.
2 [36]. Dorsal side, showing transverse lip; *a*, internal cast; *b*, section.
3 [34]. Ventral side, showing transverse lip; *a*, external cast; *b*, section.
4 [29]. A detached internal cast; *a*, dorsal; *b*, ventral; with sections at ends.
5 [31]. Fragment showing sculpture; *a*, ventral side; *b*, section.
6 [20]. An internal cast, showing form of septum.
7 [12]. Interior of operculum
8 [14]. External cast of operculum } referred with reserve to this species.
9 [18]. Internal cast of operculum

Hyolithus biconvexus, sp. nov. × 2. (See p. 152.)

10. Type-specimen [31]; *a*, exterior of dorsal side, with *b*, enlargements to 4 diameters to show character of sculpture.
11 [36]. Fragment of exterior of ventral side.
12 [34]. Internal cast; *a*, dorsal side; *b*, section.

Hyolithus alatus, sp. nov. × 2. (See p. 151.)

13. Type-specimen [34]; *a*, dorsal side exterior; *b*, side view; *c*, section.
14 [37]. Ventral side, showing lip slightly notched, with section.
15 [33]. Internal cast, side view.
16 [14]. *a*, internal cast of operculum referred with reserve to this species; *b* and *c*, side and axial views in outline.

Hyolithus Willsi, sp. nov. Nat. size. (See p. 152.)

17. Type-specimen [27 and 28]. An exfoliated dorsal side with form of shell shown by the weathered ventral side.
18. Same specimen, side view in outline, reconstructed.
19, 20. Same specimen, diagonal sections at fractures XX and YY.

Hyolithus æquilateralis, sp. nov. × 2. (See p. 153.)

21. Type-specimen [2]. *a*, exterior ventral side and interior dorsal side; *b*, section.
22. Co-type [25]. Internal casts of two invaginated shells; *a*, ventral side; *b*, dorsal.

Salterella (?) cf. *S. curvata*, S. & F. × 4. (See p. 154.)

23 [38]. Exterior.
24 [38]. Internal cast of a second specimen.

Micromitra cf. *Phillipsi*, Holl, sp. × 5. (See p. 154.)

25 [37]. External cast, with side view of a squeeze.

Helcionella (?) *emarginata*, sp. nov. × 3. (See p. 155.)

26. Type-specimen [46]. An internal cast. *a*, summit view; *b*, side view; *c*, anterior view.
27. Co-type [46]. *a*, internal cast of a second specimen, side view; *b*, fragment of the external cast showing character of sculpture.

Stenotheca abrupta, S. & F. (?). × 3. (See p. 156.)

28 [3]. *a*, internal cast; *b*, outline of aperture.
29 [5]. Internal cast.

Coleoloides typicalis, Walcott, var. *multistriata*, nov. × 2. (See p. 154.)

30 [38]. Two specimens, showing slight taper.
31. Type for var. [38]. *a*, exterior; *b*, character of sculpture. × 6.
32 [30]. A very minute tube, × 2.

Fordilla troyensis, Barrande (?). × 3. (See p. 156.)

33 [15]. Exfoliated exterior.

Platyceras primævum, Billings (?). × 4. (See p. 155.)

34 [37]. Internal cast.

II.—Cyclones and Climate.

By R. Mountford Deeley, M.I.C.E., F.G.S.

FROM time to time I have been given an opportunity to discuss in the Geological Magazine the question of the cause or causes of climatic variations. The subject is one of deep interest to the geologist. Even Lyell, in the first edition of his *Principles of Geology*, gave a good deal of space to it, but contented himself with merely pointing out that variations in the distribution of the land would lead to changes in the climate. He wisely limited himself to this aspect of the question, for, at that time, the directions of the winds in middle latitudes were not such as meteorological theory would have led us to expect.

The view was held in Lyell's time that the winds were the result of the varying temperature of the air from place to place. The centre of a cyclone came to be considered as consisting of a column of warm air with cooler surroundings. The central warm air rose, became chilled by expansion, and threw down its moisture in the form of clouds, rain, hail, snow, etc. But the two great permanent cyclones of the earth lay over or in the neighbourhood of the two poles of cold, just where it seemed impossible, or very unlikely indeed, that a warm column could exist. This was the great "stumbling-block" to all progress. Indeed, it was held by many that, as further information of the climatic conditions of the polar areas was obtained, it would be found that there were really polar anticyclones within the polar cyclones. But the barometric pressures found within the Arctic Sea, and at the most southerly portion of the Ross Antarctic Barrier, show that such polar anticyclones do not exist, and the strength and constancy of the "brave south-westerly winds" of the southern oceans continued to be one of the greatest of scientific puzzles.

At the end of the nineteenth century meteorologists began to turn their attention to the study of the conditions obtaining in the upper air. Small balloons, having attached to them self-registering thermometers and barometers, were sent up to sound the atmosphere, and very unexpected results were obtained. It was found that up to a variable height of about ten kilometres the temperature gradually

fell at such a rate as very nearly to establish a condition of convective equilibrium. This condition is one such that air moved from one height to another, owing to the expansion or compression it undergoes, changes its temperature so as to agree with that of the surrounding air. This layer of the atmosphere has been named the troposphere. Above it the temperature conditions are quite different, for the temperature either varies little with increasing height or actually becomes much warmer. This upper layer has been called the stratosphere.

In the troposphere the conditions of temperature are such that the free flow of the air is possible in re-entrant paths, both horizontally and vertically. But such is not the case in the stratosphere. Here rising air would be chilled and find itself on a level with air warmer than itself, and air falling would rise in temperature and be on a level with air colder than itself. For this reason vertical air currents of any strength must be almost entirely absent in the stratosphere, but horizontal movements may take place freely, or the whole may rise or fall bodily.

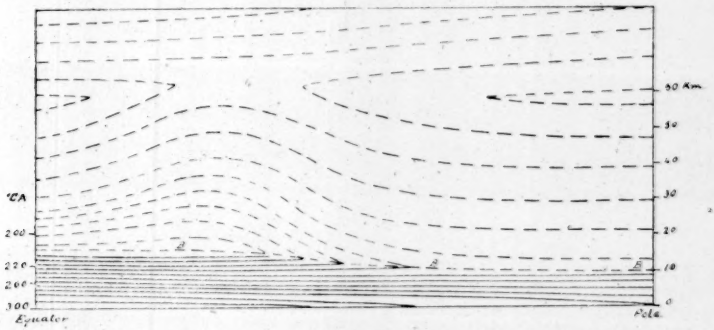


FIG. 1.

Many thousands of self-registering balloons have been sent up and much detailed information obtained concerning the temperature conditions of the atmosphere in different latitudes and at various heights.

The point of supreme interest is, of course, the temperature difference between cyclonic and anticyclonic areas. Strange to say, there has proved to be little difference between the temperature conditions existing in the great polar cyclones and those of the smaller wandering ones, which affect our climate so much from day to day.

The most astonishing feature of the cyclone proved to be that, in the troposphere, the centre of the cyclone was colder than its margins, just the opposite to what had been considered likely. Far too much importance was at first attached to this peculiar fact, for it unduly discredited the broad teaching of the "temperature gradient" theory of cyclones. Indeed, Aitkin has shown that although in the troposphere the temperature is lower in the centre of the cyclone than at its margins, owing to its lower pressure, the air is really lighter.

Anticyclonic areas are now regarded as being the normal conditions of the atmosphere in which cyclones move, rather than as special features of the atmospheric distribution of temperature and pressure.

Fig. 1 is a diagrammatic section of the atmosphere from the equator to the pole. The isothermal lines drawn in full are in accordance with the teachings of registering balloon soundings, but the dotted lines are purely theoretical. The great rise of the isothermals over latitude 30° is probably more pronounced in the diagram than it should be. B B is the line of separation between the stratosphere and the troposphere. Discussion now centres itself mainly on what takes place where these two portions of the atmosphere meet.

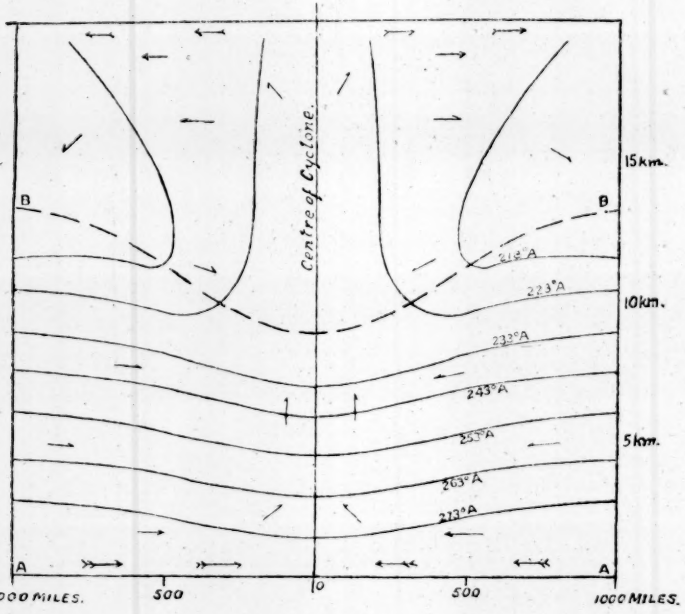


FIG. 2.

As a result of the consideration of a large number of atmospheric soundings Dines has drawn a diagram showing the temperature conditions obtaining in the average cyclone. It is shown in Fig. 2. Here the arrows indicating the probable nature of the very slow general circulation of the air, to and from the centre of the cyclone, have been added by the writer. The similarity of the temperature distribution shown by these two diagrams is very striking. The line of junction B B separating the stratosphere from the troposphere dips down in the travelling cyclone just as it does in the polar cyclone.

Such are the facts, as near as they are known, with regard to the temperature distribution in the atmosphere. It remains to consider the cause of this peculiar distribution and its bearing upon the theory of cyclones.

The temperature of the earth's surface and of the atmosphere is much above that of space, owing to the radiations received from the sun, and also very probably owing to the bombardment of cosmic matter to which the atmosphere is subjected at its upper limit. Not only do we receive heat from the sun in the form of heat and light rays and X radiations, but it has been shown that electrons are being shot out from the sun at enormous velocities. These electrons, when they reach the magnetic field of the earth, are captured and are directed in long spirals towards the poles, where they give rise, among other phenomena, to the auroral lights. Meteors, both large and small, strike the atmosphere at high velocities and heat it, and there would seem to be pencils of high velocity cosmic matter, which are also arrested by the atmosphere.

The energy thus directed earthwards is mainly either arrested by the upper atmosphere or by the lower portion of the troposphere and the earth's surface. The radiant energy which is arrested by the upper atmosphere heats the air, and this heat passes downwards to the lower portions of the stratosphere by radiation and conduction, not by convection. The undulations, to which the clear atmosphere is transparent,and which pass through it, are intercepted by the earth's surface and by clouds, water vapour, and carbonic acid. This lower warmed stratum of air then rises and cools by expansion, with the result that the troposphere assumes the condition of convective equilibrium.

Balloon ascents show that above cyclones the air of the stratosphere is warmer than it is above anti-cyclonic areas, and that the lower boundary of the stratosphere is lowest near cyclonic centres. But in Fig. 2 the air is shown to be rising in the centre of the cyclone, and it has been suggested that if the air is rising in such areas the line B B should bulge upwards.

As already remarked, Aitkin, in a paper read before the Royal Society of Edinburgh in June, 1916, showed that although the core of a cyclone is colder than the surrounding regions of high pressure, yet the air in the cyclone is lighter. This low density is due to the air being under a lower pressure, and this more than compensates for the lower temperature; so that though the air in cyclones is colder, yet it is lighter than the surrounding air, and the central core, therefore, tends to ascend both in the troposphere and the stratosphere.

In *Nature* for January 30, 1919, Dines remarks: "Mr. Deeley's suggestion (*Nature*, January 16, p. 385) that the cyclone is caused by the high temperature of the stratosphere does not seem to me to be feasible for the following reason: Owing to the temperature inversion, or, at least, to the cessation of the lapse of temperature with height, the boundary between the troposphere and stratosphere is, in general, perfectly definite, as definite almost as the boundary between oil and water would be. If then any sort of sucking action

—to use an incorrect but convenient expression—were exercised by the lightness of the air above the boundary, it ought to draw up the boundary itself as well as the air below it. This is exactly the reverse of what happens; the boundary bulges downwards in the cyclone and upwards in the anticyclone."

However, the air in the stratosphere and troposphere does not differ as do oil and water. The difference is merely one of temperature, and if the heat of the stratosphere is flowing downwards in the direction of the temperature gradient, faster than the air is rising, then, in spite of rising air, the boundary will bulge downwards. The bulging downwards of the isotherms right up to the boundary of the troposphere above proves that the air is rising there. To refer again to the letter in *Nature* by Dines, it will be seen that he says, "But if we postulate an outward radial sucking force acting horizontally on the water just below the common boundary, the water will rise from below at the centre, the common boundary will fall, and the layer of oil will thicken, and this is just what occurs in the layers of air . . . *but I do not see how an outward acceleration can be applied horizontally to the layers of air at the top of the troposphere.*" The italics are my own. Considering that the downward bulge of the isotherms of the troposphere occurs close up to the stratosphere, there is no room for such an outward flow, nor has such a flow ever been detected.

Owing to the large diameter of the cyclone and its thinness, even if there should be a considerable flow inwards the rise of the air over the whole area would be small. When much rain is thrown down in a cyclone it is not due to a general rise of the air, it is due to one current mounting another current locally. It is more reasonable to suppose that the explanation of the downward bulge of the boundary is due to the downward penetration of heat being more rapid than the upward rise of the air.

It is impossible to account for the existing climatic conditions of the earth on the assumption that the winds are produced entirely by the temperature distribution in the troposphere; for the direction of the winds of middle latitudes is opposed to the temperature gradient. It is the heating of the upper side of the stratosphere (the upper limits of the atmosphere) that results in the winds flowing in the troposphere towards the poles from middle latitudes, in spite of the ground temperature gradient.

A polar sea, with low land or islands, well connected with the great oceans, would remove to a large extent the present surface temperature gradient, which tends to lessen the force of the ground winds flowing polewards, and would enable the effect of the high temperature of the stratosphere (over the poles) to strengthen the winds flowing towards the poles. These winds would induce ocean currents flowing in the same direction. Indeed, given fairly open water connexions between the Arctic Sea and the great oceans, there is no reason why the Polar area should not be tropical in its climate.

III.—On Borings at Cotefield Close and Sheraton, Co. Durham (Permian and Coal-measures).

By David Woolacott, D.Sc., F.G.S.

During the last year I have examined, through the kindness of Mr. E. O. Forster Brown, Min. Eng., borings that have been put down by Messrs. Bell Bros., at Cotefield Close and Sheraton, near the southern limits of the Northumberland and Durham Coalfield. They are situated about 5 miles west of Hartlepool, and about 8½ miles east of the Permian escarpment at Ferryhill. The boring at Cotefield Close lies about 1½ miles east of Hurworth Burn station, and about the same distance south of that at Sheraton. The details of the former are from my own notes which were taken when the hole was finished, but those of the Sheraton cores are by Dr. C. T. Trechmann, who examined them as they were brought up from time to time, it thus being possible to obtain a very full record. I also desire to thank this geologist for some notes on the Sheraton boring which are incorporated in this paper. Both of the boreholes passed through the superficial deposits and Permian strata into the Coal-measures, but as that at Sheraton has just entered the last-named series and is not yet completed, the remarks on the Carboniferous rocks refer only to the strata pierced at Cotefield Close. The examination of these cores adds to our knowledge of the Permian, confirming some of the points that Dr. Trechmann and I have enunciated in previous papers dealing with the Magnesian Limestone. The boring at Cotefield Close is also of interest because it penetrated the Lower Coal-measures beneath the Brockwell Seam and gives a section of the little-known Ganister Series. It is hoped in a subsequent note to deal with any noteworthy features that may arise in connection with the Carboniferous rocks of the Sheraton borehole.

It is known that the Coal-measures in the south of Durham rise to the south beneath the Permian and are cut by the Butterknowle fault, which throws them down to the south so that a small area of northerly and steeply dipping measures lies on the south of this fracture.[1] It was to obtain the limits of this area, which has been proved to contain workable coal at Fishburn and Trimdon, that the Cotefield Close boring was put down, while that at Sheraton was to get information regarding the nature of the coalfield to the north of the fault.

As the particulars regarding the boreholes will doubtless in the course of time appear in the volumes of the Borings and Sinkings of the North of England Institute of Mining Engineers, it is not proposed to give the minute details regarding each bed, but to describe the general characteristics of the strata and discuss the points of geological interest. In many cases it is impossible to give the exact thickness of a bed as only the more solid portions were brought up in the core, the softer granular beds being ground down.

[1] Sections of *The Coal Seams of Northumberland and Durham Coal-field*, by J. B. Simpson, 1877; section in Lebour's *Geology of Northumberland and Durham*, 1886, etc.

These rocks came to the surface as loose dolomitic grains and were recorded as "Sand" by the borers.

DETAILS OF THE BORING AT COTEFIELD CLOSE (PERMIAN).
Altitude, 340 feet.

Boulder-clay, etc., 106 feet.

Middle Magnesian Limestone. Total thickness about 240 feet.

a. Grey cellular and spongy limestone, the calcium carbonate having segregated out of a dolomitic rock, leaving cavities filled with soft yellow dolomite. Bands of crystalline calcium carbonate also occurred. About 85 feet.	Segregated Limestone
b. Soft yellow bedded dolomitic limestone. About 39 feet.	
c. Bed consisting of loosely cemented dolomitic rhombs. This bed was ground down and came to the surface as a yellow granular sandy-looking powder, being called "sand" in the records. About 36 feet.	Granular Dolomite
d. Dolomitic roestone, an oolitic limestone with geodes containing crystals of dolomite and calcite. About 80 feet.	Dolomitic Oolite

Lower Magnesian Limestone. Thickness about 270 feet.

e. Soft and hard dense yellow limestone, with streaks and specks of manganese dioxide (about 33 feet), passing gradually into	Dolomitic Lower Limestone
f. Brown dolomitic limestone (about 118 feet), graduating by alternating irregular bands into	
g. A hard grey highly calcareous rock with carbonaceous partings. The surfaces between the layers were irregular and knobbly, a peculiarity due to pressure solution. Parts of this rock had a brecciated appearance, being crowded with numerous irregular fractures. About 100 feet.	Calcareous Lower Limestone
h. Brown dolomitic limestone. About 20 feet.	
i. Hard grey calcareous laminated bed, resting unconformably on Coal-measure Sandstone. 1 ft. 3 in.	Marl Slate

Total thickness of Permian, 513 feet.

DETAILS OF THE BORING AT SHERATON (PERMIAN). Supplied by Dr. Trechmann.
Altitude, 380 feet.

Drift gravel and boulder-clay. 187 feet.

Middle Magnesian Limestone. Total thickness about 213 feet.

a. Hard whitish spongy brecciated calcareous rock, with small cavities filled with powdery dolomite. About 90 feet.	Segregated Limestone
b. Brownish-yellow spongy-looking rock with small cavities filled with crystals of dolomite and calcite, a good deal of soft dolomitic rock interbedded with it.	
c. Dark yellowish-brown dense crystalline rock.	
d. Spongy-looking yellowish-brown crystalline rock, largely made up of dolomitic rhombs.	Granular Dolomite
e. Yellow, dense, rather soft dolomitic rock, with many small irregular oolite grains and small cavities filled with calcite crystals interbedded with hard brown thin bands without oolitic structure, changing in places into a spongy looking rock.	Dolomitic Oolite
f. Dark-yellow dolomitic oolite, with calcite-lined geodes. This bed is very thick, and merges into	
g. Fine-grained light yellowish-brown soft but dense dolomite, in which very dwarfed specimens of the following fossils occurred: *Bakevellia ceratophaga*, small serpulids, and ostracod valves. This rock is a fine dolomite.	Equivalent of bedded dolomites on the west side of reef as exposed in Castle Eden Dene
h. Similar to above, but no fossils, passing down into	

Lower Magnesian Limestone. 286 feet thick.

i.	Hard yellow dense dolomitic rock.	Dolomitic and Calcareous Lower Limestone, 166 feet
j.	Ditto, brecciated with sparry cavities, passing gradually down into	
k.	Hard grey calcareous limestone, with carbonaceous partings and calcite-filled geodes (about 5 feet), passing down into	
l.	Brown dolomitic limestone, brecciated in places. About 7 feet.	
m.	Calcareous grey limestone with sparry cavities.	
n.	Hard brown dolomite.	
o.	Calcareous grey limestone.	
p.	Brown brecciated dolomite.	
q.	Hard brown dolomite, with patches of calcareous limestone.	Calcareous Lower Limestone, about 120 feet
r.	Brown brecciated dolomite with sparry cavities.	
s.	Hard grey calcareous rock, brecciated in places.	
t.	Hard grey calcareous rock with sparry geodes.	
u.	Grey calcareous rock, brecciated in places.	
v.	Hard dark laminated Marl Slate. 1 foot.	Marl Slate
w.	Grey hard dark calcareous limestone. 3 inches.	"Yellow" Sands, 3 ft. 6 in.
x.	Coarse grit, small irregular chips and fragments of crinoidal limestone and chert in a matrix of rounded quartz grains interspersed with pyrites crystals.	
y.	Grey sandstone with rounded grains.	
z.	Grey shale, the rounded grains of the Yellow Sands impressed on the surface of the shale at the junction.	Coal-measures

Total thickness of Permian, 504 feet.

The first rock met with under the drift was apparently in both of the borings the Middle Magnesian Limestone, there being no trace of the typical upper beds as they appear in the area nearer the coast, such as the Hartlepool and Roker dolomites (dolomitic oolites and soft yellow dolomite) with the typical fauna of the Upper Magnesian Limestone, nor the Concretionary and the Cannon-ball Limestones, nor the bed which I have taken as the base of the Upper Limestone series, viz. the Flexible Limestone. These upper beds occur on the east of the Shell Limestone reef and also on the top of the reef in some places; for instance, Dr. Trechmann records the cannon-ball limestone as occurring on the top of the Shell Limestone in the Blackhall Colliery sinking. We are of opinion that owing to the shrinkage of the sea in later Permian times the upper beds were not deposited much to the west of the Reef.[1]

In neither of the borings was any trace of the richly fossiliferous Bryozoa Reef of the Shell Limestone found. At Blackhall Colliery sinking 3½ miles to the north-east nearly the full thickness of this bed—335 feet—was pierced, and Dr. Trechmann was able to study the zones of it.[2] Both of these borings are west of the Reef and pass through a series of beds which are the western equivalent of it. The Sheraton boring is probably less than a mile from it. In Castle Eden Dene, 3½ miles to the north, rather high beds of the Reef are exposed at Ivy Rock. They are here full of fossils and merge westwards into a fine-grained, very pure, dolomitic bedded rock, which if

[1] Woolacott, "Stratigraphy and Tectonics of the Permian of Durham (Northern Area)": Proc. Univ. Durham Phil. Soc., vol. iv, pt. v, p. 268, 1911–12. Trechmann, "On the Lithology of certain Durham Limestones": Q.J.G.S., vol. lxx, p. 260, 1914.

[2] Q.J.G.S., vol. lxix, p. 213, 1913.

carefully searched yields a very scanty and dwarfed fauna, consisting of *Bakevellia antiqua*, Munst., *B. ceratophaga*, Schl., *Schizodus truncatus*, King, *Pleurophorus costatus*, Brown, *Astarte vallisneriana*, King, and *Spirorbis permianus*, King. The bed marked "g" in the Sheraton boring with *Bakevellia ceratophaga*, small serpulids, and ostracod valves, is the exact equivalent of these beds. The reef-like nature of the Shell or Fossiliferous Limestone thus receives further confirmation from these borings.

The sections of the Middle Limestone given in these boreholes are therefore of much interest as they add considerably to our knowledge of the little-known western equivalents of the Reef. In the northern part of the county the remnant of them occurs as a bedded fossiliferous magnesian limestone, the main mass having been everywhere denuded, but in the south they are found as a series of cellular segregated rocks and granular, oolitic, and bedded dolomites over 200 feet thick. The segregated part of the former rocks are nearly pure calcium carbonate with powdery dolomitic infilling in the cavities, while the latter beds are almost pure dolomites.[1] In both borings thick beds of dolomitic oolite occurred. Such beds are of much more frequent occurrence in the Magnesian Limestone than is generally thought to be the case.

These segregated, oolitic, and granular dolomites are the in-shore equivalents of the Bryozoa Reef. To the east the Reef is replaced by the off-shore beds consisting of segregated and yellow bedded rocks, from which no fossils have yet been recorded, and which are often more pseudo-brecciated and brecciated than the rocks on the west. The Middle Magnesian Limestone thus presents two distinct types of bedded rocks with the shell-bank of the Bryozoa Reef lying between.

The top of the Lower Limestone is fairly well marked in each borehole by the merging of the Middle beds into a hard dense yellow dolomite with carbonaceous partings. The bedded series beneath consists of 280 feet of yellow and brown dolomitic and grey calcareous limestone. These at one or two horizons alternate in irregular bands, but beds over 100 feet thick of both types occur. The grey calcareous rocks are among the purest of the whole of the Magnesian Limestone series, containing over 98 per cent of calcium carbonate, and are very similar in composition and appearance to Carboniferous Limestone. They are distinctly hard and solid, but in places have suffered a process of brecciation, generally apparently more or less contemporaneous with the deposition of the beds. Some of the more pronounced brecciation in these beds has, however, been

[1] A. D. N. Bain, B.Sc., has analysed these rocks and supplied me with the following figures:—

Granular Dolomite.		*Oolitic Dolomite.*	
Dolomite	62·38	Dolomite	82·47
Calcite	30·10	Calcite	17·46
Ferric oxide	3·88	Ferric oxide	·4
Insoluble residue	3·46		
	99·82		100·33

brought about by causes that have operated later.[1] At Raisby Hill Quarry, near Trimdon, a few miles to the west, these dolomitic and calcareous rocks are well exposed in a face 100 to 180 feet high.[2] At the quarry the highly magnesian rocks are called "Basic Dolomite or Crusher Stone", and the purer rocks are called "Bluestones".[3] The grey limestones are often fossiliferous. Although no fossils were found in the cores, yet at Raisby Hill they yield fossils, and further west at East Thickley a bed 10 feet in thickness yields a well-preserved and fairly rich fauna of the Lower Limestone. The borings confirm the discontinuous and lenticular nature of these calcareous beds, which Dr. Trechmann has noticed in connection with the field exposures.

[In the Sheraton boring the limestone became more impure and passed down into the Marl Slate (1 foot thick), beneath which the yellow sands (3½ feet) occurred. The former bed was hard and compact, and beneath it was, as is frequently the case, a band of grey calcareous limestone. No fish-remains were noted in the samples brought up. The Yellow Sands formed the base of the Permian series. At the surface outcrops along the escarpment this consists of a bed of incoherent rounded grains, plentifully stained with iron oxide and irregularly bedded. In its original unweathered condition the bed is here a solid rock with a remarkable quantity of iron pyrites disseminated through it. The upper layers at Sheraton are noticeable for the quantity of other fragments of rock embedded in the matrix of rounded quartz grains. Among these pieces of Carboniferous crinoidal limestone, fragments of chert and bits of grey sandstone occur. A similar rock is recorded from Blackhall Sinking, but such fragments do not occur in the north of the county nor along the escarpment.[4]—C. T. T.]

The decrease in the thickness of the Yellow Sands at Blackhall

[1] e.g. the thick irregular coarse dolomitic breccias occurring in the calcareous limestone of Raisby Hill Quarry.

[2] The section of the Lower Limestone at Raisby Hill is :—

	Feet.
Soft Dolomite "Crusher Stone" (hard and pure dolomite, 10–40 feet)	50–90
"Mixed blue" (dolomitic limestone)	0–28
"Bluestone" (highly calcareous rock)	28–54
Dolomite	10
Marl Slate	1
Top of Yellow Sands.	

A coarse irregular dolomitic breccia occurs in the "Bluestone".

[3] The following analyses of these rocks have been forwarded to me by T. A. Saint, B.Sc., assistant quarry manager :—

Basic Dolomite ("*Crusher Stone*").		*Bluestone.*	
$CaCO_3$	53·58	$CaCO_3$	98·75
$MgCO_3$	44·64	$MgCO_3$	·77
Silica	·10	Silica	·54
Ferric oxide	·88	Alumina and peroxide of iron	·30
Alumina	·8		100·36
	100·00		

[4] [In an arenaceous limestone at the base of the Lower Limestone on Tynemouth Cliff, stems of Carboniferous Limestone crinoids occur.]

Colliery, Sheraton, and Cotefield Close confirms the view that the Yellow Sands die out in the South of Durham. This thinning out is irregular but continuous. The fragments of Lower Carboniferous rocks occurring in the Yellow Sands, and the thinning out of this bed southwards, prove that the ridge of Carboniferous rocks that lay to the south was exposed at the time of the deposition of the basal beds of the Permian, and was being denuded until rocks of the limestone facies were laid down. It is interesting to compare the Permian in the boring at Cotefield Close with that at Sheraton about 1½ miles to the north-east and at Blackhall Colliery 2 miles further in that direction. Thicknesses are given in feet.

	Blackhall Colliery.	Sheraton.	Cotefield Close.
Upper Limestones	82	Absent.	Absent.
Middle Limestones	335 feet of fossiliferous rock, forming the Bryozoa Reef.	213 feet of segregated, granular, and oolitic dolomite, fossiliferous on one horizon.	240 feet of unfossiliferous rock similar to that at Sheraton.
Lower Limestones	240	286	271
Marl Slate	5	1	1¼
Yellow Sands	26	3½	Absent.
Total thickness of Permian	688	504	513

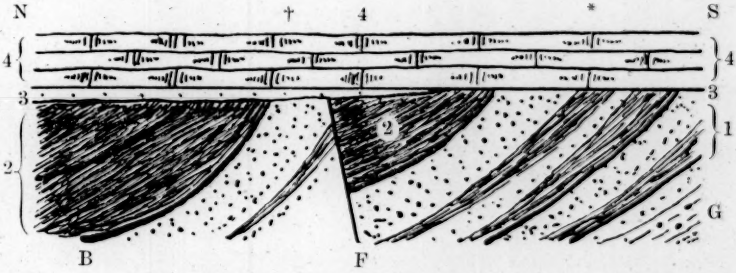
While the boring was being put down at Cotefield Close, after a depth of about 250 feet had been reached the air rushed in to the borehole and at other times out of it. This it did for days at a time, varying with the height of the barometer, and proving in a noticeable manner the porous and cavernous nature of the Middle Magnesian Limestone.

Coal-measures (Cotefield Close).

The borings at Cotefield Close and Sheraton entered the Coal-measures at a depth of 278 and 311 feet respectively beneath sea-level. As the line of the Butterknowle fault runs between them the Permian here is not affected by this fracture, which has a considerable throw to the south in the Coal-measures beneath. At Butterknowle, 20 miles to the west, this fault has a downthrow to the south of from 80 to 90 fathoms.[1]

[1] Kirkby & Duff, "Geology of Part of South Durham": Nat. Hist. Trans. of Northumberland and Durham, vol. iv, pt. i, 1871.

The unconformity between these series was distinctly marked at Cotefield Close. The Permian beds were lying without any marked dip, but the rocks below were dipping at about 1 in 4 (15°), probably in a northerly direction. They were penetrated by the boring for 470 feet. For about 370 feet they were a series of yellow, brown, and red sandstones, and felspathic grits, alternating with beds of grey, greenish, and reddish shales, and fireclays. A fairly coarse conglomerate occurred near the top. At one point contemporaneous erosion of the shales had taken place, as fragments of shale were interbedded with the sandstone, the laminations of the pieces lying at various angles in regularly bedded sandstone. Interbedded with this series were five thin seams of coal (the thickest being 11 inches). Remains of the ordinary Coal-measure plants were common in the shale, such as *Lepidodendron*, *Stigmaria*, *Calamites*, but no trace of any characteristic fossil such as *Aviculopecten papyraceus*[1] was found.



DIAGRAMMATIC SECTION SHOWING TERMINATION OF THE COAL-MEASURES IN SOUTH DURHAM.

1. Ganister Series: beds of sandstone, felspathic grits, shales, fireclays, and thin coal-seams with beds of Ganister (*G*) at base. The sandstones probably thicken northwards, and these beds on north side of fault are chiefly sandstones.
B. Brockwell Seam.
2. Coal-measures.
3. Yellow Sands thinning out southwards and overlaid by Marl Slate.
4. Magnesian Limestone. Only the lower part of this bed is shown.
No attempt is made to draw the beds to an exact scale.
F. Butterknowle Fault.
* Approximate position of Cotefield Close borehole.
† Approximate position of Sheraton borehole.
The length of the section is about 4 miles.

Below these rocks several beds of Ganister alternating with beds of shale and finely bedded micaceous sandstone were proved. The thickest bed was 4 feet, and was of the "pencil" variety. The occurrence of this Ganister is of some interest, because the beds between the Brockwell Seam and the Millstone Grit are called the Ganister Series, and are taken as the equivalents of the true Ganister-bearing rocks of Yorkshire and Lancashire. It is proved

[1] Professor Lebour found this fossil along with other marine fossils in beds occupying a similar position to these at Whittonstall (GEOL. MAG., 1878, p. 144).

by this boring that there are over 300 feet of Coal-measure strata beneath the Brockwell in South Durham which do not contain any Ganister. This rock only occurs in the lower part of the series.[1]

Samples of the most interesting rocks brought up in the Cotefield Close boring are deposited in the geological laboratory of the Armstrong College.

I should like here to lay stress upon the necessity for the examination of all cores of borings by geologists. The record given by the borers, especially in such rocks as the Magnesian Limestone, is often of little value for exact scientific work, and valuable information is thus lost.

IV.—Notes on Ammonites.

By L. F. Spath, B.Sc., F.G.S.

IV.

THE variability and occasional instability of the Ammonoid suture-line, to which attention has been drawn, the recurrence of similar types, and the frequent asymmetry of the opposing halves of a given suture-line, which is apparent not only in the *Dactylioceras commune*, figured by Swinnerton & Trueman (fig. 9 on p. 42), but also in the development of the suture-line in e.g. *Pseudosageceras multilobatum*, Noetling,[2] in *Indoceras baluchistanense*, Noetling,[3] or in *Oxynoticeras oxynotum*, Quenstedt, sp.,[4] to mention only a few well-illustrated examples, might be thought to impair the usefulness of the suture-line for the classification of Ammonoids. Yet, long before there was any subdivision of "*Ammonites*" at all, the greatest importance had been attached to the foldings of the suture-line, and Pictet stated in 1854 that "the lobes in their essential traits furnished very constant and very valuable characters".[5] Von Buch's group of "*Arietes*" was well characterized by the general plan of the suture-line, namely, the deep siphonal lobe and the short external saddle, only most authors would put more reliance on the ornamentation of the shell and put such a form as *Asteroceras sagittarium*, Blake, sp., into the genus "*Aegoceras*". The writer would even go so far as to say that the type of suture-line given by Mr. Buckman[6] for "*Defossiceras*" *defossum*, Simpson, sp., should not be found at the horizon stated,[7] and that the form probably will turn out to be an Arietid (*Agassiceras*) of *semicostatum* age.

[1] The borehole at Sheraton appears also to have entered the Ganister Series. Thick beds of sandstone have been penetrated dipping at an angle of 45°, probably northwards, as shown in section.

[2] "Untersuchungen ü. d. Bau d. Lobenlinie v. *Pseudosageceras multilobatum*, Noetling": Palæontographica, vol. li, pts. v, vi, 1905.

[3] "Die Entwicklung v. *Indoceras baluchistanense*, Noetling": Geol. u. Pal. Abh. v. Koken, N.F., vol. viii, pt. i, 1906.

[4] "Die Entwicklung v. *Oxynoticeras oxynotum*, Que.": Geol. u. Pal. Abh. v. Koken, N.F., vol. viii, pt. iv, 1908.

[5] Op. cit., vol. ii, p. 669.

[6] *Yorkshire Type Ammonites*, vol. ii, pt. x, p. 76, pl. lxxvi, 1913.

[7] Definitely given as "*capricornum* zone" in Mr. Buckman's "Palæontological Classification, etc.", in *The Geology of the Country between Whitby and Scarborough* (Mem. Geol. Surv.), 2nd ed., 1915.

Wright[1] expressed the opinion that von Buch had considered the suture-line of much greater importance than was justified by later observations, and he stated: "In adult life, however, the form of the suture-line is a valuable character." H. Douvillé,[2] ten years later, took an exactly opposite view. He thought that the best family characters would have to be furnished by the plan of the suture-line, i.e., its general course in the post-goniatitic stage before it was masked by the complication of the lobes and saddles. Fischer,[3] on the other hand, thought that "the suture-line was of real value for classificatory purposes only when used in conjunction with other characters of a 'higher' order, such as the general form of the shell, its ornament, mouth-border, or aptychus. If the suture-line were the absolute basis for a classification of Ammonites, this would have been accomplished long ago, since from von Buch's time onward all palæontologists had kept this character in view. Unfortunately no one could affirm to-day that there exists a satisfactory classification of this group of cephalopods".

Noetling[4] also thought that the systematic value of the suture-line was not very great, since the protrusions of the visceral hump that went into the lobes were of no importance. Opinions may differ on this latter point, for in living animals even specific differences are often very fundamental and extend to quite minor internal structures or to the convolutions of the brain.[5]

It is not the writer's intention to give a complete history of the alternate favouring and disfavouring of the suture-line as a basis for the classification of Ammonoids, but it is surprising that, though opinions on its value were freely given, little research as to the nature and origin of the folded septal edge was carried on. It must be admitted, however, that among modern workers on Ammonoids many look upon the suture-line as the dominant feature, and Hyatt[6] even went so far as to say that "all classifications were necessarily based upon sutural peculiarities". In view of the importance of this statement it seems advisable to examine the other features of the Ammonoid shell that have been used for classificatory purposes.

With regard to the form of the shell and the coiling, their value for a natural classification of Ammonoids is strictly limited. Few authors would now group certain Inferior Oolite forms (*Patoceras*)

[1] *Monograph of the Lias Ammonites*, Pal. Soc., 1880, p. 219. Only seven years after the compilation of Wright's work, hailed at the time of its appearance as a "masterly monograph" (A. Geikie, *Text-Book of Geology*, 1882, p. 786), Professor Blake ("The Evolution and Classification of the Cephalopoda, etc."): Proc. Geol. Assoc., vol. xii, p. 292, 1892) had to say with regard to the classification adopted by Wright, namely that of Neumayr, originally published in 1875: "Its author, were he happily still with us, would certainly regard it as quite inadequate and out of date at the present time."

[2] "Sur la Classification des Cératites de la Craie": Bull. Soc. géol. France, ser. III, vol. xviii, pp. 280, 291.

[3] Discussion on above, ibid., pp. 291–2.

[4] Op. cit., 1905, pp. 59–60.

[5] A. v. Tschermak, "Über d. Entwicklung d. Artbegriffs": Tierärztl. Zentralblatt (34), Vienna, 1911, pp. 351, 381.

[6] In Zittel-Eastman, *Textbook of Palæontology*, 1st ed., vol. i, p. 546, 1900.

with the Cretaceous *Ancyloceras* or *Toxoceras*, as, e.g., d'Orbigny and Pictet did, simply because they are of a similar shape. There is no generic connexion among most of the scaphitoid or other "aberrant" forms that appear at a number of horizons and may originate from very distant stocks, though they have a similar form. De Loriol [1] describes an aberrant form that occurs together with *Cardioceras cordatum* as *Œcoptychius Christoli*, Beaudouin. It is evident that this form has no connexion with the earlier type of *Œcoptychius*, namely *Œ. refractus* (de Haan), from the *anceps* zone. There is not even similarity of shape, and the form is probably a modified development of some contemporaneous group of Ammonites such as *Pachyceras*. It has also been mentioned already that it is impossible to group together the Devonian *Biloceras* and the Triassic *Sageceras*, or the Cretaceous *Garnieria* and the Liassic *Oxynoticeras*, simply because they are similar in appearance. It will be noticed that geological occurrence is a determining factor in the separation of many of these lineages based on a modified whorl-shape; *Spiroceras* is strictly Callovian, *Ancyloceras* confined to the Lower Aptian. Unfortunately this has given rise to a multitude of new names, but the creation of separate genera for the various abnormal whorl-shapes antedates the splitting up of the genus "*Ammonites*" by Suess, Hyatt, and Waagen.

Impossible as it may be to use form and coiling of the shell for a general classification, certain Ammonites (e.g., *Phylloceras*) can at once be recognized by their form, and when this is modified (e.g., in *Sowerbyceras*) a separate name is given to the new stock. The same thing applies to the coiling in *Lytoceras* where evolution gives rise to, e g., *Costidiscus* and *Macroscaphites*. In the great majority of Ammonites, of course, form and coiling vary considerably within a genus; e.g., in *Cadoceras* there are compressed shells and greatly depressed cadicones, in *Morphoceras* there is involution and evolution, in *Schlotheimia* the whorl may become almost oxynote (*S. Greenoughi*). When form and coiling change within a species group, what older authors termed thick and thin, evolute or involute "varieties" of the species are produced. But the term "variety", which has a definite zoological meaning, is not favoured by modern palæontologists, who, on the other hand, often do not make enough allowance for individual variation within a species. It may be inadvisable to give a new name to every form that differs, often only very slightly, from the type in thickness or involution; but it seems to the writer equally objectionable to identify, e.g., a Yorkshire *Psiloceras* with an Alpine form only because their dimensions agree (for in both the *erugatum* and the *calliphyllum* species-groups similar variations would probably have occurred), or, as Hyatt has done, identify an *Amioceras* from Peru with *A. ceras*, Giebel, sp., when there is such a distinct change in the *Amioceras* fauna even from Gloucestershire to Dorset on the one hand and to Yorkshire on the other. It is known from the study of living mollusca that in the sea each locality gives its

[1] "Etude sur les Mollusques et Brachiopodes de l'Oxfordien Supér. et Moyen du Jura Bernois," Supplément I: Mém. Soc. Pal. Suisse, vol. xxviii, pp. 20–2, 1901.

inhabitants its own peculiar stamp; but when an Ammonite is described as, e.g., *Phylloceras mediterraneum* (Neumayr) race *indica*, Lemoine, or as *Protogrammoceras cornacaldense* (Tausch) var. *zeugitanum*, Spath, it is not certain that it really represents a horizontal variant or race, and not a vertical mutation. In fact, these terms can rarely be safely employed, and an attempt to trace the mutations of, e.g., *Quenstedtoceras* through R. Douvillé's beds H_1 to H_6 shows the unsatisfactory and difficult nature of their use. But on the examination of many hundreds of specimens of a variable species such as *Hystrichoceras varians* (Sowerby), *Cardioceras cordatum* (Sowerby), or *Xipheroceras planicosta* (Sowerby) (out of one block or bed, and, therefore, apparently contemporaneous) and as an alternative to using the term "variety" or creating new names, the use of the trinomial nomenclature suggests itself for these thick and thin, involute or evolute, weakly or strongly ornamented variations, as employed by, e.g., Solger for *Hoplitoides ingens nodifer*, *H. ingens costatus*, and *H. ingens lævis*. Wepfer[1] also reintroduces Quenstedt's trinomial nomenclature, but in a different sense. The genetic relationship between the Bajocian *subradiata*-group and the Tithonian *lingulati* is too uncertain to include them all in the genus *Oppelia*, and, moreover, even such names as *Glochiceras lingulatus carschtheis*, *Gl. lingulatus lævis*, and *Gl. lingulatus crenosus*, covering forms from different facies and different horizons between the *bimammatum* zone and the Tithonian, would not be admissible.

What has been said with regard to the form and coiling applies also to the use of the ornamentation of the shell for classificatory purposes. Von Buch's sections with a keeled or grooved venter, or Mojsisovics's divisions of Liostraca and Trachyostraca, were soon found to be unnatural groupings. "*Aegoceras*" *sagittarium*, Blake, is an *Asteroceras*, though it has no keel; "*Oxynoticeras*" *Greenoughi* (Sowerby) is a *Schlotheimia* though it has no ventral groove. An Argovian *Neumayriceras*, e.g., may have a groove on the ventral region of the chambered portion which, generally with the beginning of the body-chamber, changes into a keel. This passes into an interrupted line of tubercles which, disappearing abruptly, may again give way to a groove. According to whether this groove or the dentation is more pronounced, there are several combinations; at the same time the sides are often conspicuously smooth and the body-chamber often becomes abnormal and depressed.[2] And all this in one and the same form. Again, the presence of a hollow carina, though occasionally constant, and the thickness of the siphuncle—at one time considered a distinction between "*Harpoceras*" and Oppelids—cannot be used for classificatory purposes.

Mojsisovics had at first[3] considered all post-Triassic Ammonites, except *Phylloceras* and *Lytoceras*, to be descendants of the

[1] "Die Gattung *Oppelia* im süddeutschen Jura": Palæontographica, vol. lix, pp. 1–68, 1912.

[2] Wepfer, op. cit., p. 17.

[3] "Die Cephalop. d. Mediterr. Triasprovinz": Abh. k.k. Reichsanst., vol. x, 1882.

Trachyostraca. In his later work,[1] however, he assumed, conformably to the general opinion, that the whole of the Jurassic and Cretaceous Ammonites issued, by branching, from the family of the Phylloceratidæ, i.e. Liostraca. Steinmann,[2] on the other hand, still maintains a purely artificial classification into Trachyostraca, Hemiostraca, Liostraca, and Heterostraca. J. Boehm[3] also emphasizes that from the study of *Kossmaticeras* it was clear that the systematic division of Cephalopoda according to the mode of ornamentation was an artificial one, and that stress was to be laid above all on the ontogenetic development.

But though unsuitable for general purposes, the ornamentation or carination may be of considerable value for the minor groupings of Ammonoids. The course of the radial line in certain Hildoceratids,[4] the different types of costation in the Perisphinctids, an important classificatory character, and in the ribbed descendants of *Psiloceras*, the tendency to differentiate costation either on the venter (with first thickened and then interrupted ribs) or on the side (with eventual carination of the ventral area) separate the two important families of Schlotheiminæ and Arietidæ. In the former, the development that leads up to a grooved periphery (in the ontogeny of the later forms) is separated generically (as *Waehneroceras*) from the forms of the succeeding hemeræ that have a similar tendency to lead back from a grooved periphery to a rounded venter (*Schlotheimia*). The terms anagenesis and catagenesis are avoided by the writer not only because, for example, a smooth (so-called catagenetic) form may show elaboration of all its other characters, but also because he considers the smooth oxycones in many stocks to be specialized

[1] "Die Ceph. d. Hallstätter Kalke": Abh. k.k. Reichsanst., vol. vi, 1873–93, 2 vols.

[2] *Einführung in die Palaeontologie*, 2nd ed., 1907.

[3] *N. Jahrb. f. Miner.*, etc., ii, p. 463, 1912 (in review of Kilian & Reboul's paper on certain neo-Cretaceous Ammonites).

[4] The writer used this character in the subdivision of the Middle Liassic (Domerian) Hildoceratids ("On Jurassic Ammonites from Jebel Zaghuan": Q.J.G.S., vol. lxix, pp. 547–52, 1913) and separated the Flexiradiata from the rectiradiate forms that constitute the genus *Seguenziceras*. The genus *Protogrammoceras* was created for the former, and two divisions were recognized within that genus; but one of these, characterized by dionase in peripheral projection and including subanguliradiate and angulirursiradiate forms, is covered by the genus *Fuciniceras* created just prior to the publication of the writer's paper. The genus *Protogrammoceras* will, therefore, have to be restricted to the forms of the first subdivision, including subfalciradiate and falciradiate forms (type "*Grammoceras*" *bassanii*, Fucini, "Apenn. Centr.," pl. x, fig. 6, 1900). Apart from their Domerian age, both the Rursiradiata (*Fuciniceras*) and the Falciradiata (*Protogrammoceras*) are distinguished from the Toarcian Harpocerates by their combination of evolute whorls with a tendency to change the periphery from fastigate to carinatisulcate and back again to fastigate. The form described and figured in that paper as gen. nov. sp. nov. (?) (pl. lii, fig. 2, p. 556) belongs to the group of forms wrongly referred to *Harpoceratoides* by Haas, and the new genus *Lioceratoides* (type "*Lioceras* (?)" *Grecoi*, Fucini, "Apenn. Centr.," Pal. Ital., vol. vi, p. 65, pl. xi, fig. 4, 1900) is now proposed for this development, characterized by a type of costation very distinct from that of the other Domerian Hildoceratids.

adaptations, corresponding to elaborately ornamented sphærocones or uncoiled shells in other lineages.

In the family Arietidæ, the hastening in development of one character of the whorl or its ornamentation faster than another, or the delaying of a feature, afford valuable indications of the beginning of diversity of lineages. During the acme of the group, certain Alpine forms of *Coroniceras* show a tendency to retard the development of the keel and to flatten the periphery, which tendency probably leads to the Microderocerates. Other Alpine *Coroniceras*-forms hasten the development of the keel and foreshadow the somewhat later *Aetomoceras*, which seems to be a corresponding development of the bituberculate *Agassiceras*. In the later genus, again, the tendency to omit the keel and to continue the costation across the venter probably leads to *Xipheroceras* and thus starts the family Aegoceratidæ, from which the *Microderoceras* development, mentioned above, would, obviously, have to be excluded. It will be seen that the tendency of a lineage to develop or specialize in a certain direction (adaptative in response to changes of environment or intrinsic and aiming at diversity) is here favoured as the basis of lineal independence and generic classification, as opposed to the morphological method of grouping together forms that fit the generic diagnosis of the textbooks, or to the cyclical method which assumes that stocks should develop according to a given "cycle" and show periods of "anagenesis" and "catagenesis".

Suess,[1] when first venturing on the subdivision of Ammonites, thought the length of the body-chamber and the shape of the mouth-border characters of systematic value. The former generally depends on shape and coiling, and Buckman and Bather[2] have pointed out that in *Stephanoceras* the body-chamber "varies in length from about half a whorl in the thick forms (the supposed females) to very nearly two whorls in the thin forms (the supposed males)". As a specific distinction this character alone has been used by Pompeckj,[3] who described as *Psiloceras brevicellatum* an Ammonite that differs from *P. planorbe* only in having a shorter body-chamber. On the other hand, G. von Arthaber[4] bases what appears to the writer to be a very artificial classification of Triassic Ammonites into Microdoma and Macrodoma, on the length of the body-chamber. He also states that "much more important than generally assumed seems to be the convergence of forms", but groups such heterochronous homœomorphs as *Beloceras* and *Sageceras* together.

As regards the shape of the mouth-border, great variability is shown even in one genus, e.g., *Phylloceras*, as H. Douvillé[5] pointed out. Of course, it might be objected that this genus really ought to be subdivided into a number of genera, but Douvillé thinks even the ornament of the sides "perhaps more important for classificatory

[1] "Über Ammoniten": Sitzungsber. d. Wiener Akad., vol. lii, p. 71, 1865.
[2] *Nat. Sci.*, vol. iv, p. 428, 1894.
[3] "Beitr. z. einer Revis. d. Amm. d. Schwäb. Jura," 1893, pt. i (T).
[4] "Grundzüge einer Systematik d. Triad. Amm.": Centralbl. f. Min., etc., 1912, p. 245.
[5] "Cérat. de la Craie": loc. cit., pp. 278–9.

purposes than the shape of the aperture". The presence or absence of lateral lappets at the mouth-border is used for classification by Maseki,[1] who put *Parkinsonia* and *Strenoceras* into the family Otoitidæ, *Baculatoceras* into Stemmatoceratidæ, *Garantiana* and *Subparkinsonia* into Stephanoceratidæ. But Wetzel[2] has found "ears" in a small form of *Garantiana* and only very slight lateral processes in larger forms, and he thinks that probably—as is the case also in *Parkinsonia*—in certain series the "ears" disappeared with age, earlier in some series and later in others. Again, in *Hecticoceras*, *Glochiceras*, and other Oppelids "ears" are often confined to the younger stages, "vary in form and size from one specimen to another, and show by this alone an impress of individuality that seems to deny them any usefulness for systematic purposes."[3]

When Waagen, in 1871, combined the Ammonitid genera in eight groups, he attributed "great importance to the presence or absence of the shell-plates termed *Aptychus* and *Anaptychus*, and to the particular structure of these remains".[4] Wright[5] also expressed the opinion that "the *Aptychus* played an important part in the organic functions of this large extinct group of tetrabranchiate Cephalopods". But it had been shown long before that, in the case of Gastropods, as the operculum sometimes varies in structure in species of the same genus, as it is present in some volutes, cones, mitres, and olives, and absent in other species of these genera, and as some genera in a natural family, as *Harpa* and *Dolium* among the Buccinoids are without an operculum, whilst the other genera of the same family possess that appendage, it obviously affords characters of very secondary importance.[6] H. Douvillé[7] thought that "there was nothing to show that in one and the same family one might not find *Aptychi* of the same form that could have been either horny or else more or less impregnated with calcareous matter, the former would have disappeared during fossilization, at least in the majority of cases, whereas the latter would be preserved. The absence of the *Aptychus* might, therefore, be only apparent, and it was a character of little importance". The assumption that the operculum of Cephalopods has a greater systematic value than that of Gastropods, even if not homologous, is not justified. Apart from this our scanty knowledge of *Aptychi* found together with their parent Ammonites has proved a great practical difficulty, and Waagen's classification was, from this point of view, unsuccessful.

Mr. Crick[8] thought that the traces of muscular attachment of the

[1] "Die *Stephanoceras*-Verwandten der Coronatenschichten von Norddeutschl.": Dissertat., Göttingen, 1907.

[2] "Beitr. z. Pal. u. Stratigr. d. nordwestdeutschen Jura, ii, Faunistische u. stratigr. Untersuch. d. *Parkinsoni*-Schichten d. Teutoburger Waldes bei Bichfeld": Palæontographica, vol. lviii, p. 159, 1911.

[3] Wepfer, op. cit., p. 40.

[4] Zittel, *History of Geology and Palæontology*, English trans., 1901, p. 403.

[5] Op. cit., 1880, p. 176.

[6] R. Owen, *Lectures on the Comparative Anatomy and Physiology of the Invertebrate Animals*, 1843, p. 296.

[7] "Cérat. de la Craie": loc. cit., p. 278.

[8] "On the Muscular Attachment of the Animal to its Shell in some Fossil Cephalopoda (Ammonoidea)": Trans. Linn. Soc., vol. vii, pt. iv, p. 109, 1898.

Ammonoid animal to its shell afforded important characters for the purposes of classification, but both on account of the comparative scarcity and the indefinite nature of these impressions they have not proved of value yet in the classification of Ammonites.

On the whole, then, the Ammonoid suture-line may be considered to be a more useful feature for classificatory purposes, especially of the larger groups and families, than any of the above characters, though, like any other character, it cannot be used by itself as the sole basis for the natural classification of organisms that are made up of an almost infinite number of characters, each of which is in a continuous state of movement, either originative, progressive, or retrogressive.[1] Holzapfel[2] stated long ago that one single character, such as the shape of the first suture, the direction of the siphonal funnel, or the shape of the peristome, cannot well be used for classification. In his paper on the genus *Oppelia*[3] Wepfer stated: "In palæontological works the question is often asked, which characters in Ammonites are decisive, the lobes, the length of the body-chamber, etc., etc.? I believe they all are, to a certain extent' but one cannot formulate general rules. All characters are liable to variation, and what decides is the general appearance, at any rate we get further with this than with following some one-sided character." Hyatt's classification of the Nautiloids[4] according to the structure of the septal neck, though more attractive than the previously existing classifications, cannot be really natural, and when it is found that Hyatt[5] included, e.g., in his family Estonioceratidæ, based on the shape of the whorls, beside the Ordovician genus *Estonioceras*, also the Jurassic *Digonioceras*, that is two genera that almost certainly have not the remotest affinity, the artificial character of his classification becomes evident. The same applies to his classification of Ammonoidea, as is shown, by the inclusion in, e.g., his *Leptocampyli* of such a heterogeneous mixture of Ammonoids belonging to widely removed stocks, or his separation of such closely allied genera as, e.g., *Reineckeia* and *Erymnoceras*, *Sigaloceras* and *Kepplerites*, not only into different families, but even different super-families.

It seems to the writer that the development of the Ammonite suture-line has to be studied from its first "angustisellate" beginning, and used as a basis for classification only in conjunction with the development of all the other characters of the shell. The use for general classification of, e.g., the symmetrical or asymmetrical arrangement of the first lateral lobe, the changing width of the external saddle, the number of auxiliary lobes, or any other similar peculiarity of the suture-line, by itself, is unsatisfactory.

[1] H. F. Osborn, "Origin of Single Characters as observed in Fossil and Living Animals": Presidential Address Pal. Soc. Amer., 1914 (see *Nature*, November 11, 1915, pp. 284–5).

[2] "Die Cephalopoden-führenden Kalke d. Unt. Carbon v. Erdbach-Breitscheid bei Herborn": Pal. Abh. v. Dames u. Kayser, vol. v, No. 1.

[3] Loc. cit., 1912, p. 30.

[4] *The Genera of Cephalopods*, etc., 1883.

[5] In Zittel-Eastman, op. cit., 1900.

V.—Some Recent American Petrological Literature.

(*Continued from p. 128.*)

"Structure of the Anorthosite Body in the Adirondacks," by H. P. Cushing. Journ. Geol., vol. xxv, pp. 501–8, 1917.

A criticism of Dr. Bowen's conclusions as to the field relations of the different rock-types of the area.

"Adirondack Intrusives," by N. L. Bowen. Ibid., pp. 509–12, and H. P. Cushing, ibid., pp. 512–14.

A continuation of the discussion on the two preceding papers.

"The Relation of the Titaniferous Magnetite Ores of Glamorgan Township, Haliburton County, Ontario, to the Associated Scapolitic Gabbros," by W. G. Foye. Econ. Geol., vol. xi, pp. 662–80, 1916.

It is concluded that gases given off by the acid and intermediate magmas collected beneath the gabbro, oxidizing its iron to titaniferous magnetite and depositing this below the laccolith; the chlorine and other gases thus set free scapolitized and recrystallized the overlying gabbro.

"The Relation of the Titaniferous Magnetites of North-Eastern Minnesota to the Duluth Gabbro," by T. M. Broderick. Econ. Geol., vol. xii, pp. 663–96, 1917.

The gabbro has developed magnetite-bearing rocks along its contact with the Gunflint iron formation, including coarse-textured fayalite-pyroxene-magnetite rocks, hitherto mistaken for marginal facies of the gabbro. Several types of magnetic ores within the gabbro are partly magmatic segregations and partly inclusions of the Gunflint formation.

"The Geology of Pigeon Point, Minnesota," by R. A. Daly. Amer. Journ. Sci., vol. xliii, pp. 423–48, 1917.

A re-examination of the occurrence of micropegmatite (red rock) in a basic intrusion. The intrusion is considered to be a sill, not a dyke, as supposed by Bayley, and the variation in composition is due to differentiation, mainly by gas-action, after stoping and assimilation of Animikie quartzite.

"Petrography of the Pacific Islands," by R. A. Daly. Bull. Geol. Soc. Amer., vol. xxvii, p. 325, 1916.

The available data lead to the conclusion that the primary Pacific magma is basaltic and that andesites and ultrabasic lavas have been differentiated from this: certain alkaline types may be limestone syntectics.

"A Contribution to the Petrography of the South Sea Islands," by J. P. Iddings and E. W. Morley. Proc. Nat. Acad. Sci., vol. iv, pp. 110–17, 1918.

Analyses are given of rocks from Tahiti and other islands of the Georgian and Society groups, many of which are profoundly eroded volcanoes, consisting mainly of basalts rich in augite and

olivine, with little felspar: at five of them are late trachytic and phonolitic lavas, while two show coarsely crystalline cores of gabbro or theralite and in one case syenite and nepheline-syenite.

"Age of the Igneous Rocks of the Adirondack Region," by A. P. Cushing. Amer. Journ. Sci., vol. xxxix, pp. 288–94, 1915.

The orthogneisses which have been metamorphosed along with the Grenville rocks have been invaded by the anorthosite-syenite group, which contain inclusions of the gneisses. It is held that the orthogneisses and the anorthosite-syenite group are distinct and should not be classed together.

"The Composition of the Average Igneous Rock," by A. Knopf. Journ. Geol., vol. xxiv, pp. 620–2, 1916.

Using the data given in Daly's *Igneous Rocks and their Origins*, the writer calculates a new average igneous rock, taking into account the actual volume of each type, so far as known. This average is found to agree very closely with that previously given by Clarke.

"The Summation of Chemical Analyses of Igneous Rocks," by H. H. Robinson. Amer. Journ. Sci., vol. xli, pp. 257–75, 1916.

An application of the laws of probability to the determination of errors of summation, as a guide to the quality of the analytical work.

"Use of the Slide-Rule in the Computation of Rock Analyses," by J. H. Hance. Journ. Geol., vol. xxiii, pp. 560–8, 1915.

The author gives two tables of the percentage composition of rock-forming and ore minerals with a method of use applicable to an ordinary slide-rule for the conversion of analyses into the corresponding mineral compositions.

"Suggestions for a Quantitative Mineralogical Classification of Igneous Rocks," by A. Johansen. Journ. Geol., vol. xxv, pp. 63–97, 1917.

The basis of the proposed classification is a figure in the form of a double tetrahedron, each corner representing certain mineral constituents of the rock, the composition of any type being represented graphically in its proper position in the figure. The minerals are divided into groups and a large number of new rock-names are proposed.

"Types of Prismatic Structure in Igneous Rocks," by R. B. Sosman. Journ. Geol., vol. xxiv, pp. 215–34, 1916.

Several types of prismatic structure are distinguished as due to thermal contraction, convection in the still liquid magma, and internal expansion respectively.

"The Microscopical Characters of Volcanic Tuffs, a Study for Students," by L. V. Pirsson. Amer. Journ. Sci., vol. xl, pp. 191–211, 191 .

A discussion of the origin and characteristic structures of tuffs, with a description of the criteria for their recognition when altered, weathered, and metamorphosed.

REVIEWS.

I.—New and little-known Gastropoda from the Upper Cretaceous of Tennessee. By Bruce Wade. Proc. Acad. Nat. Sci. Philadelphia, vol. lxix, pt. ii, pp. 280–304, pls. xvii–xix, 1917.

We have referred in a previous issue (Geol. Mag., 1917, p. 471) to the notable results of Dr. Bruce Wade's study of the Gastropod fauna from the Upper Cretaceous Ripley formation of Coon Creek, in McNairy County, Tennessee. The fossils from this locality are in a remarkable state of preservation, and consequently afford excellent material as a basis for the establishment of new generic types. We have now before us a second contribution, in which further new forms are established. Among them is *Conorbis mcnairyensis*, a new species founded on a single specimen, which is the only member of the Conidæ in the fauna. This record is important on account of its being the first typical representative of the genus in the Upper Cretaceous; it shows all the salient features exhibited by Sowerby's *Conus dormitor*, the type of the genus *Conorbis*, from the Eocene of Western Europe.

Three new genera in the Volutidæ are established, and a new species is assigned to Grabau's *Falsifusus* and to Conrad's *Linosoma*, also of this family. *Hyllus* is a genus (type, *H. callilateras*, n.sp.) of large, unornamented volutes, with expanded bodies and low spires. The characteristics of this genus resemble those of *Liopeplum*, but there are differences in the form of the spire and the disposition of the columellar plaits. The new genus *Boltenella* (type, *B. excellans*, n.sp.) includes a group of well-defined forms of fulguroid shells, with large paucispiral protoconchs and subdued ornamentation, probably intermediate between the Busyconidæ and the Fusidæ. *Scobina* is a generic name given to a number of shells similar in general shape to *Hercorhynchus*. The strongly inflated body resembles Conrad's *Rapa cancellata* from the Cretaceous of India, but in the new genus there is a marked increase with age in the spiral angle. *S. bicarinata*, n.sp., is the genotype. The new species assigned to the genus *Falsifusus*, *F. mesozoicus*, is a fragile, slender shell, marked by spinose terminations of the axials along the shoulder angle. This form and Kaunhowen's *Fusus bicinctus* are the first two species from the Upper Cretaceous to be referred to *Falsifusus*. In another genus, *Lirosoma*, a new species (*cretacea*) is again recorded for the first time from the Cretaceous. This form resembles the generic type from the American Miocene.

The Buccinidæ are represented by one new genus, *Seminola* (type, *S. crassa*, n.sp.), named after a tribe of Indians who formerly inhabited the south-eastern coastal plain. The genus resembles Meek's *Odontobasis*, of which the fusiform outline distinguishes it from the globose form of *Seminola*.

An elegant little pyriform shell, with a depressed spire, *Ecphora prôquadricostata*, n.sp., has again the interest of being the first representative in the Cretaceous of a genus well known in the Upper Tertiary of the Atlantic Coast district. Belonging to the same

family, the Purpuridæ, is a new genus, *Paramorea* (type, *P. lirata*, n.sp.), which can be distinguished from *Morea* by the presence of a narrow, oblique chink instead of a well-defined umbilicus, by an acute spire, and by the absence of the strongly reflected inner lip.

Two genera new to the Cerithiidæ are also established. *Nudivagus* (type, *N. simplicus*, n.sp.) includes a group of simple, elongately conical shells, with no external ornament. To this genus, moreover, Stoliczka's Indian Cretaceous *Cerithium* (*Fibula*?) *detectum* and Hudleston's *Pseudomelania astonensis*, from the Inferior Oolite of England, are also referred. *Astandes* (type, *A. densatus*, n.sp.), a small trochoid shell, resembles Conrad's *Cerithioderma* in outline, but its spire is less acuminate and the umbilicus imperforate. By its short anterior canal, also, it can be distinguished from Gardner's *Paladmete*, which otherwise it resembles. Included in this new genus is Holzapfel's *Tritonium cretaceum*, from the Aachen Cretaceous.

Acirsa and *Hemiacersa* belong to the Scalidæ; of the former two new species are described and one of the latter. The form named *Chemnitzia cerithiformis* by Meek and Worthen is now considered to be an *Acirsa*, and Kaunhowen's Maestrichtian *Scalaria densestriata* is probably comparable with *A. corrugata*, n.sp. De Boury's *Hemiacersa* is enlarged by the inclusion of *H. cretacea*, n.sp., of which the single example is notable on account of its being the first recorded from the Upper Cretaceous. The present contribution to the systematic study of this fauna ends with the establishment of the new genus *Creonella*, belonging to the Pyramidellidæ. The genotype, *C. triplicata*, n.sp., is a small, slender, conical shell, like *Pyramidella*, and is characterized by three conspicuous folds on the inner lip.

We await with interest the results of Dr. Bruce Wade's further studies on this fauna.

C. P. C.

II.—A Bibliography of Indian Geology and Physical Geography, with an Annotated Index of Minerals of Economic Value. Compiled by T. H. D. La Touche, M.A., F.G.S., F.A.S., Bengal. Published by Order of the Government of India, and printed in Calcutta for the Geological Survey of India. London: Kegan Paul & Co. Imp. 8vo. Part I (1917), pp. xxviii + 571, price 5*s.* 4*d.*; Part II (1918), pp. 490, price 6*s.*

THE author of this important work is a man well qualified for the task, having served for thirty years upon the staff of the Geological Survey of India, to the "Records" of which he was himself a frequent contributor. During his long service he was a careful and diligent compiler of references bearing upon both geology and physical geography and on the mineral resources of India. He had also the advantage of being able to make use of Mr. R. D. Oldham's very complete bibliography, presented to the Geological Survey of India in 1888. The earlier additions made by the author to Mr. Oldham's work have been largely due to his long English residence

in Cambridge, by which he had access to the libraries of the Cambridge University, the Geological Society of London, the India Office, the British Museum, the Imperial Institute, the Science Museum, the Royal Geographical Society, and the Institute of Civil Engineers. Thanks are also recorded by the author for assistance given him by many State Geologists who have aided in his work.

The first volume (dated 1917) is devoted to a Bibliography of Indian Geology and Physical Geography, under authors' names, prefaced by 23 pages of abbreviated titles used in the work (all alphabetically arranged).

The second volume (dated 1918) contains an "Annotated Index of Minerals of Economic Value"; this is intended to be used in conjunction with the bibliography (which, indeed, is included and really forms part of this work).

The figures inserted in brackets after the observer's name correspond to the serial number allotted to each author, followed by the number of the page on which the reference will be found.

A list of works dealing generally with the distribution of economic minerals in India is given under provinces and authors, for India, Burma, Madras, Punjab, and Rajputana, the names of minerals being arranged alphabetically: e.g. Alum, Amber, Chromite, Coal, Copper ore, Corundum, Diamonds, etc., so that no separate index is required.

Much information relating to the mineral resources of the country collected within recent years is stored up in the progress reports and correspondence files of the Geological Survey Department in Calcutta, where it may be studied by those who are interested in the subject, either in its scientific or commercial aspects.

The matter comprised under the general heading "Building Materials" (pp. 27–62) is of course very complex in its nature, embracing descriptions and localities for limestones, sandstones, slates, quartzites, granites, marbles, basalts, gneissic rocks, laterites, serpentinous limestones, dolomites, etc., in great variety.

By this valuable compilation Mr. T. la Touche has conferred a great service on all who are seeking information on Indian geology. He has given us in these volumes a ready reference to the authors of all books and papers, not only relating to the geology and physical geography of our Indian Empire, but also to its economic minerals and rocks and the localities in which they are found. It is a book which should find a place in the reference works of every scientific library, but is much too large to carry in one's handbag.

III.—A Mystery Crinoid.

On *Mysticocrinus*, a new genus of Silurian Crinoidea. By Frank Springer. Amer. Journ. Sci., xlvi, pp. 666–668, pl. ii, Nov. 1918.

THE genotype is *Mysticocrinus wilsoni*, of which the holotype and a fragment were obtained by Dr. Herrick E. Wilson from the Laurel formation near St. Paul, Indiana, and are in the Springer Collection at the U.S. National Museum. The crown, with stumpy infolded arms, is like a wrinkled pea in size and shape. The cup

consists of 3 unequal infrabasals (the small one right posterior), 5 basals, 5 radials, a radianal (forming the lower part of r. post R.), and a long anal *x*. This last rises in a spearhead between the adjacent arms; the other arms are separated by similar spearheads, formed from both shoulders of the anterior radial and the right and left shoulders of the right and left posterior radials; the antero-lateral radials have no such processes. The arms consist of 2 primibrachs followed by equal rami of 3 secundibrachs, except in the antero-lateral rays, which have but one primibrach. The tumid cup-plates and the short square brachials of the short arms give the crown a massive appearance, despite its small size.

Dr. Springer assigns this new genus to no Family, and is, indeed, uncertain as to the Order, though describing it as a Dicyclic Inadunate "intermediate between the Larviforma and the Fistulata". If by this he means phylogenetically intermediate, he is deriving dicyclic forms from monocyclic, which is unjustified. He excludes it from the Flexibilia because there is "no indication of loose suture or flexibility in cup or tegmen". None the less *Mysticocrinus* would seem better placed in that Order. The tegmen in any case is unknown, and in so small a cup it would be hard to see any indications of loose suture. The anal *x* recalls that of *Lecanocrinus*, as Dr. Springer says, also that of *Anisocrinus*. The tightly-closed arms resemble those of *Lecanocrinus* and still more those of *Mespilocrinus*. The inadunate character of the arms is primitive and is paralleled by *Pycnosaccus*, which has wide interbrachial areas occupied by small irregular plates. That genus and *Lecanocrinus* also display a tendency to have a single primibrach instead of the two usual in the early Flexibilia. The primitive position of the radianal is retained also in the Silurian Flexibilia, *Clidochirus* and *Ichthyocrinus*.

When Dr. Springer's great Monograph of the Flexibilia reaches this country we shall see to which of his Families *Mysticocrinus* might be referred. Its "mysterious" characters are due partly to its primitive stage of development and partly to conditions, probably of a reef-like nature, such as have so often produced similar forms.

F. A. Bather.

IV.—Notes on the Geological Structure of the Vale of Kingsclere. By H. L. Hawkins. Proc. Hampshire Field Club, vol. viii, pp. 191–212, with 4 plates, 1918.

THE author gives an interesting sketch of the stratigraphy of the Vale of Kingsclere, with a general account of the development of the Cretaceous and Tertiary deposits. As a result of his palæontological work in the Upper Chalk, he proposes to subdivide the *coranguinum* zone, which is of unwieldy proportions, by marking off the upper portion as the "sub-zone of *Conulus albogalerus*". Some modifications are also suggested in the reading of two well-sections, affecting the assignment of certain beds to the London Clay and Reading Beds respectively. The most important part of the paper, however, is concerned with the tectonics of the district. A detailed

study of the strike of the strata indicates that the periclinal structure of the district is modified by the interference of two anticlines and a syncline having a N.N.W.–S.S.E. strike and parallel to the East London ridge. These folds, though of very slight amplitude, nevertheless produce a marked effect on the strike of the Cretaceous rocks and are possibly due to slight posthumous movements of the Charnian fold-series. Hence it is possible that Palæozoic rocks may underlie the district at no great depth.

V.—Geological Observations in Fiji. By W. G. Foye. Proc. Amer. Acad. Arts and Sci., vol. liv, pp. 1–145, with 1 plate and 40 figs., 1918.

PROFESSOR FOYE spent seven or eight months of 1915–16 in a geological expedition to the islands of the Fiji group, chiefly for the purpose of studying coral-reefs at first hand, and this long paper gives an account of his observations and the conclusions drawn from them. The first part, entitled "Geological History of Fiji", describes the physiography and stratigraphy of the islands, and discusses the living and raised reefs in considerable detail. The larger islands possess a plutonic core and two series of sedimentary rocks, the older, probably Miocene, being folded along trend-lines parallel to those described by Suess in other parts of Oceania, the younger unfolded and apparently post-Tertiary. Four separate volcanic phases are recognized with a regular gradation in acidity, namely, (1) rhyolite, (2) andesite, (3) andesite, (4) basalt. The elevated limestones rest unconformably on eroded volcanic rocks, and there is abundant evidence of great instability of relative level throughout the group, partly due to uplift and subsidence and partly to return of water after the Glacial period. Hence the conditions are very favourable to the formation of reefs according to Darwin's theory. The reduction of masses of elevated limestone to sea-level has in some cases been accomplished by atmospheric solution, and slight submergence initiates the growth of reefs and atolls on these platforms. The present coral-reefs have been developed on surfaces formed by integration of a number of processes: (*a*) atmospheric erosion, (*b*) wave-cutting, (*c*) sedimentation, and (*d*) volcanic aggradation. On the other hand, it is demonstrated that the older limestones developed on a subsiding basement of eroded volanic rocks, but no evidence could be found in Fiji for the existence of Pleistocene benches; the platforms are much more modern in their development.

The second part of the paper gives a petrographic description of the rocks collected, including plutonic, hypabyssal, volcanic, pyroclastic, and sedimentary types. The igneous rocks are exclusively Pacific in their character, the most acid rock observed, with 70 per cent of SiO_2, called tonalite by the author, being composed of quartz, plagioclase, biotite, and hornblende. This appears to grade into diorite and gabbro, while the volcanic rocks are characterized by hornblende, augite, and hypersthene. It is suggested that the hornblende-hypersthene rocks have been formed by submarine eruption,

the retention of gases allowing these minerals to form, whereas subaerial eruptions without water gave rise to augite. The volcanic vents of the region appear to have been extremely persistent in their localization, since the later basalts came from the same craters as the andesites.

This paper must be regarded as a valuable contribution to the ever-growing American literature of the reef-problem and of the petrography of the Pacific Islands.

VI.—Asbestos in the Union of South Africa. By A. L. Hall. Geological Survey of the Union of South Africa, Memoir No. 12. pp. 152, with 15 plates, 16 text-figures, and a map. Pretoria, 1918. Price 5*s*.

OF late years the Union of South Africa has become an important producer of asbestiform minerals for the world's market. It possesses deposits of chrysotile, tremolite, and crocidolite, and a new and important variety, here called amosite, has recently been developed on a commercial scale in the Transvaal. In this memoir Mr. Hall gives a full account of the properties and occurrence of all these varieties. Chrysotile is found in workable quantities in the Carolina district of the Transvaal in the upper part of the Dolomite Series, a few feet above a large basic sill. It also occurs in the Tugela Valley in Natal, as described by Dr. Hatch in 1910. Crocidolite is found in very large quantities in the banded ironstones of the Lower Griqua Town Series, which are equivalent to the lower part of the Pretoria Series of the Transvaal. Amosite is an amphibole, rich in ferrous iron and pale grey or nearly white in colour, and remarkable for the great length of its fibres, which can be obtained in quantity averaging 6 inches. It is found in the Lydenburg and Pietersburg districts of the Transvaal, near the base of the Pretoria Series. The genesis of crocidolite and amosite is discussed in detail and attributed to metamorphism of ferruginous and siliceous sediments associated with rocks containing magnesia and soda. The origin of the amosite deposits is believed to be connected with the intrusion of the Bushveld complex. The industrial aspects of the subject are also dealt with.

VII.—On Sections in the Lower Permian Rocks at Claxheugh and Down Hill, Co. Durham. By David Woolacott, D.Sc., F.G.S. Trans. Nat. Hist. Soc., Northumberland, Durham, etc., n.s., vol. v, pp. 155–162, with 4 plates and 2 figures, 1918.

THE author discusses the various ways in which brecciation has been produced in the Permian rocks and describes sections showing that local disturbances have been produced by horizontal movements due to thrusting from west to east, by which part of the Marl Slate and Lower Limestone have been displaced and cut out. No suggestions are offered as to the cause of the thrusting, but reference is made to the work of Trechmann on deposits of anhydrite at Hartlepool and to the presence of sulphates in the Permian rocks of other parts of North-East England. It is suggested that the

removal of these by solution would at any rate lead to an accentuation of the effects of such movements, if produced by other agents.

VIII.—Summary Report of the Mines Branch of the Department of Mines, Canada, for the year 1917. 153 pp., with 4 figures. Ottawa, 1918. Price 15 cents.

THIS publication contains a summary of the work of the various divisions of the Mines Branch and gives evidence of great activity in several directions. Among the work of properly geological character may be mentioned reports on the iron-ores of the Rainy River district, on the limestones of Ontario, and on certain sands and sandstones. The Fuels and Fuel-testing Division investigated a large number of peat bogs in various localities, while the Ore-Dressing and Metallurgical Division carried out tests on a large number of ore samples, including gold, silver-lead, iron, manganese, chromite, tungsten, and molybdenum. The Ceramic Division examined into resources of clay and shale in several provinces, and an account is given of the manufacture of magnesite products, an industry of growing importance.

REPORTS AND PROCEEDINGS.

I.—Geological Society of London.

February 5, 1919.—Mr. G. W. Lamplugh, F.R.S., President, in the Chair.

The following communication was read—

"The Geology of the Marble Delta, Natal." By Alexander Logie Du Toit, B.A., D.Sc., F.G.S.

The paper deals with the crystalline dolomitic marbles of Port Shepstone, Natal—rocks that have already been the subject of several communications to the Society; but its main object is to demonstrate that certain "boulders" of alkali-granite, formerly regarded as inclusions, are in reality parts of intrusive tongues, and to discuss the mutual relations of the igneous rocks and the adjacent dolomites.

The main area of Marbles covers a tract of about eight square miles. It is not a solid block surrounded by granite and gneiss, but a bent and twisted mass enveloped and underlain by igneous material, and cut into several distinct portions by great intrusive sheets.

The Marbles, almost wholly dolomitic in composition, are medium to coarse-grained rocks that have their bedding-planes marked out by various contact-minerals. They reach a total thickness of about 2,000 feet, and are divided into an upper and a lower portion by a narrow belt of quartz-schist.

The plutonic rocks are, for the greater part, coarse-grained biotite- or hornblende-orthogneisses, with streaks and belts of hornblendic gneisses, schists, and granulites at or near the contacts with the Marbles. A conspicuous feature of the igneous rocks is that, for a distance of two to eight miles from the contact, they contain red and brown garnets.

In addition to the normal type of metamorphism produced by the gneiss and the granitic offshoots therefrom, there is also developed at the contacts a phase almost identical with that presented by xenoliths of limestone in volcanic rocks. Through the action of magmatic emanations, zones possessing more or less regularity have been produced in the adjacent dolomitic marble, of which the innermost is commonly rich in diopside and often in scapolite, with forsterite, phlogopite, chondrodite, and spinel farther away. The dedolomitization is usually perfect.

In the contact-zone forsterite and chondrodite are antipathetic minerals, the latter being invariably farther removed from the intrusion.

In certain cases the marble beyond the silicate-zone has been deprived of the bulk of its magnesia, and has been changed into a mass of coarsely crystalline calcite. This phenomenon has probably been due to the action of carbonated waters during the cooling of the plutonic masses.

The absorption of marble by the magma at the contacts has caused the development of pyroxene in the intrusive rock, but there is no evidence in this area of large-scale assimilation of marble by the gneiss.

II.—Liverpool Geological Society.

February 11, 1919.—W. A. Whitehead, Esq., B.Sc., in the Chair.

The following papers were read:—

1. "The Ancient Settlements in Wirral in relation to the Surface Geology." By William Hewitt, B.Sc.

A study of the geological drift map of the Wirral peninsula in relation to the early settlements in the area revealed certain points of interest. For the purpose of the inquiry the peninsula was considered as extending beyond the existing boundaries of the "hundred of Wirral" to a line running from the River Dee at Chester to the opening of the River Weaver into the Estuary of the Mersey. Of the surface so defined, approximately 64½ per cent is covered with boulder-clay and 1½ per cent with drift sand; 19 per cent is made up of various patches of Triassic rocks free from glacial deposits, while the remaining 15 per cent is covered with recent deposits. The 77 ancient settlements in the area which are either mentioned directly in the Domesday Survey Record (viz. 52) or are known from early records to have been in existence at the time of the Conquest, are situated as follows: 41 or 53 per cent on exposed rock surfaces free from drift, 2 on blown sand, 10 on drift sand, and 24 or 31 per cent on boulder-clay, this distribution showing a marked preference for a pervious foundation. A detailed classification of the settlements was given, and many particulars of interest both to the archæologist and to the geologist are recorded.

2. "Some Borings through the Marshes bordering the Southern Shore of the Mersey Estuary." By F. T. Maidwell.

In this paper full details are given of a large number of borings made in recent years by the firm of E. Timmins & Sons, Ltd.,

Runcorn, in the neighbourhoods of Frodsham, Ince, and Ellesmere Port, some of which reached a depth of over 900 feet below the surface. At Ellesmere Port evidence has been obtained of an important trough fault, and the thickness of the drift has been proved to be as much as 113 feet. None of the boreholes passed beyond the Lower Bunter Sandstone.

III.—Edinburgh Geological Society.

January 22, 1919. (Received February 14.)—Professor Jehu, President, in the Chair.

1. "The Origin of Terrestrial Vertebrates." By the President, Professor T. J. Jehu.

The ancestry of vertebrates is still an unsolved problem, and palæontology can throw little light on the subject. One theory traces their descent through a series of primitive Chordate forms represented by *Amphioxus*, the *Tunicata*, and *Balanoglossus*. The peculiar ciliated larva of *Balanoglossus*, known as *Tornaria*, shows marked resemblances to the larvæ of the echinoderms, and a form similar to this larva may possibly have been the common ancestor of echinoderms and vertebrates. Another hypothesis derives the vertebrates from the Annelida, the organs of which show a curious correspondence, but with a general reversal of the relation of the various parts to one another. A recent theory seeks the vertebrate ancestor amongst the more primitive arachnoids, now represented by *Limulus*, and formerly exhibited by the extinct group of *Merostomata*. Chamberlin's theory is that the vertebrates originated in flowing land waters as a response to the influence of strenuous dynamic conditions impressed upon a primitive animal aggregate towards the close of pre-Cambrian times. The return of migratory fishes to rivers for spawning purposes is an argument in favour of regarding flowin land waters as their ancestral home. Primitive armoured fishes are found in Ordovician sediments in Western America, and more typical fishes appeared in Europe towards the close of the Silurian period and became abundant in Old Red Sandstone times. The appearance of fishes which utilized the air-bladder for respiratory purposes at this period was the result of adaptations to oscillations of climate leading to alternate seasons of drought and rain. The life-habits of Dipnoans and fringe-finned Ganoids which have survived as relic fauna to the present day were described. These afford a clue to the conditions of life which, during Devonian time, led to lung-breathing in the Dipnoans and Ganoids of that period. Increasing aridity of climate eventually led to the emergence of vertebrates from their aquatic habitat and their adaptation to life on land. This transition is illustrated in the Amphibia which appeared at the close of the Devonian period and developed into diverse forms during the Carboniferous. The fact that the early life of amphibians is aquatic and that for a time they breathe by means of gills, shows that they were not completely adapted to a terrestrial life. The *Stegocephalia* show more resemblances to the fringe-finned Ganoids than to the Dipnoans, especially in the structure of the limbs, and more probably

evolved from that Order. At the beginning of the Permian the *Stegocephalia* gave rise to the reptiles which were able to survive more completely arid conditions and were adapted to an entirely terrestrial life. Reference was made to Broom's theory that the evolution of mammals from reptiles was rendered possible when the Theromorphs developed limbs which enabled them to carry the body off the ground. The aridity of climate during Permian times served as an incentive to speed, and the extensive glaciation, which supervened during that period in the Southern hemisphere, favoured the acquisition of warm blood and of heat-retentive clothing. In their anatomical features the Theriodonts of the Permian and Triassic bridge the gap between reptiles and mammals. This was illustrated by a description of the origin of the paired occipital condyles of the mammal from the tripartite single condyle of Theromorphs, by the gradual reduction of the bony elements of each half of the lower jaw in these reptiles, by their heterodont dentition, by the structure of the shoulder and hip girdles and other features.

2. Specimens of native gold from Rhodesia were exhibited by Dr. M'Lintock.

IV.—Geologists' Association

The annual general meeting of the Geologists' Association was held at University College, Gower Street, W.C. 1, on February 1, 1919, when the following lecture was delivered:—

"The Nimrud Crater in Turkish Armenia." By Felix Oswald, D.Sc., F.G.S.

The Nimrud volcano, situated on the west coast of Lake Van in Turkish Armenia, has a perfect crater nearly five miles in diameter. The precipices of the crater-wall rise two thousand feet abruptly from a deep lake which fills half the area of the crater. The lecturer described the external and internal features of this great volcano, which he visited and surveyed some years ago, and he gave a summary of its geological history down to its last eruption in 1441.

The lecture was illustrated by lantern-slides, photographs and drawings.

March 1, 1919.

"Some Suggestions on the Flaking and Evolution of Flint Implements." By S. Hazzledine Warren, F.G.S.

The paper dealt with the following points:—

Characteristics of the fracture of flint under internal molecular strain, flexion, tension, compression, etc. The planes of least resistance—what they are and what they mean. The designed flake and the accidental chip. Normal flaking at about 75° tending to cuneiform flakes. High angle and low angle edge-flaking tending to incurved flakes. The Levallois-Pressigny method. Suggested evolution of the Neolithic axe and double axe from special forms of palæoliths. Possible development of the Neolithic arrow-point, scraper, sickle-knife and certain other implements from the Mousterian racloir along divergent lines of evolution. The importance of wood and bone for implement making in past human industries.

CORRESPONDENCE.

TOPAZ AS A ROCK CONSTITUENT.

SIR,—When a paper on the Gunong Bakau topaz and cassiterite[1] appeared in this Magazine for 1916, it was sufficient for the time being to ask you to publish a report[2] to which the author referred in order to show that before I worked out the structure of Gunong Bakau[3] he held the view that the quartz-topaz rock was "topazised granite", and attempted to explain the horizontality of one of the ore-bodies by faults, thrusts, and a landslip, although in his paper he writes of the "important veins intrusive in the porphyritic granite", and argues that because certain topaz-bearing rocks in Germany and elsewhere are considered to be altered granitic rocks, the same origin should be accepted for the Gunong Bakau quartz-topaz rock. I do not propose to repeat the evidence on which my opinion that the topaz is a primary mineral was based, but there are two points of general interest that might be mentioned in connexion with topaz as a rock constituent.

On pp. 300 and 301 of *The Natural History of Igneous Rocks* Dr. A. Harker writes: "Closely bound up with the greisens are the tinstone veins, the cassiterite probably resulting from reaction between the volatile tin fluoride (SnF_4) and water. The destructive action of fluorides is exceedingly energetic. At Geyer, in Saxony, granite is locally converted to a rock containing more than 90 per cent of topaz," and quotes as his authority regarding the Geyer rock Salomon & His' paper in the Zeit. deutsch. geol. Gesellschaft, vol. xl, pp. 570–4, 1888. Dr. Jones follows Dr. Harker in making a similar reference to these authors; but the fact remains that whatever may be the truth about the origin of the topaz they described, Salomon & His did not write anything in that paper that justifies their being quoted as authorities for its formation by the destructive action of fluorides. On the contrary, Salomon and His made it clear that they considered the topaz in the greisen to be the primary topaz that occurs in the granite. They mentioned topaz as being widely distributed as a constituent of the granite stocks, although it seldom becomes a prominent constituent. They said that one must expect the topaz, so characteristic of the granite, in the greisen as well, and on pp. 573 and 574 they described aggregates of topaz with a little felspar and mica which become converted by decomposition into aggregates of 90 per cent topaz with a little kaolin and ferrite. According to these authors the topaz was not formed by pneumatolysis. Never having seen the Geyer or indeed any German greisens in the field, I am not in a position to say whether Salomon & His were correct in their view or the reverse.

[1] Dr. W. R. Jones, "The Origin of Topaz and Cassiterite in Malaya": GEOL. MAG., 1916, pp. 255–60.
[2] Loc. cit., pp. 453–6.
[3] Quart. Journ. Geol. Soc., vol. lxx, pp. 363–81, 1914.

On p. 379 of my paper on the Gunong Bakau rocks I pointed out that without segregation one could not expect to have a rock very rich in topaz. In a pure orthoclase magma the 18·4 per cent of alumina could only produce 32·6 per cent of topaz if attacked by fluorine unaccompanied by more alumina. Dr. Jones produces evidence to show that alumina was introduced into some greisens.[1] I do not know how the rock-sampling was carried out in the cases quoted, nor on how many analyses the results are based; but I do not wish to question the increase of alumina in any of the altered rocks in the table on p. 260 as compared with the unaltered granite. The greatest increase is 2·09 per cent, which, added to the alumina of a pure orthoclase rock, gives a possible 36·3 per cent of topaz, which is still very far short of 90 per cent, and we are not dealing with pure orthoclase rocks. There can be no question that topaz does occur as an original rock constituent. The Meldon aplite, for instance, has been described anew recently,[2] in which topaz is associated with lepidolite, tourmaline, and fluorspar, among other minerals. There is no doubt in my mind that it occurs also as a pneumatolytic alteration product. Each case must be decided on the local evidence.

J. B. Scrivenor.

YUNNAN CYSTIDEA.

Sir,—A few comments are necessary on Dr. Bather's letter in the March number of this Magazine (p. 143) in reply to my remarks on his articles on Yunnan Cystidea. Especially is this the case with regard to the diplopores in *Sinocystis*. Firstly, it must be borne in mind that the figured specimens which were lent to him for a short time for the purpose of making casts for the British Museum constitute the only material on which he can base his conclusions, while I had three times the number of specimens for study for two years. Secondly, it has not been mentioned that these figured specimens before being drawn or sent to him had been cleaned under my eyes with a weak acid solution, which I then observed attacked and partially dissolved a few of the tubercles, so as to remove the thin covering layer of epistereom in some cases and thus expose the pores. Thirdly, the other specimens of *Sinocystis*, numbering over twenty, which Dr. Bather never saw, were examined by me as they came fresh from their limestone matrix, unaffected by weathering, untouched by any solvent, and often only partly exposed. These did not show any pores on the hundreds of tubercles which I scrutinized, except where the tubercles were obviously injured. Fourthly, his statement that on removing a piece of the matrix from one of my figured specimens there was disclosed a tubercle exhibiting the minute pores completely confirms my experience that there is extreme difficulty in getting rid of the closely adherent matrix without damaging the surface, and thus his discovery is of

[1] Op. cit., pp. 259–60.
[2] Geol. Mag. 1919, pp. 41–2.